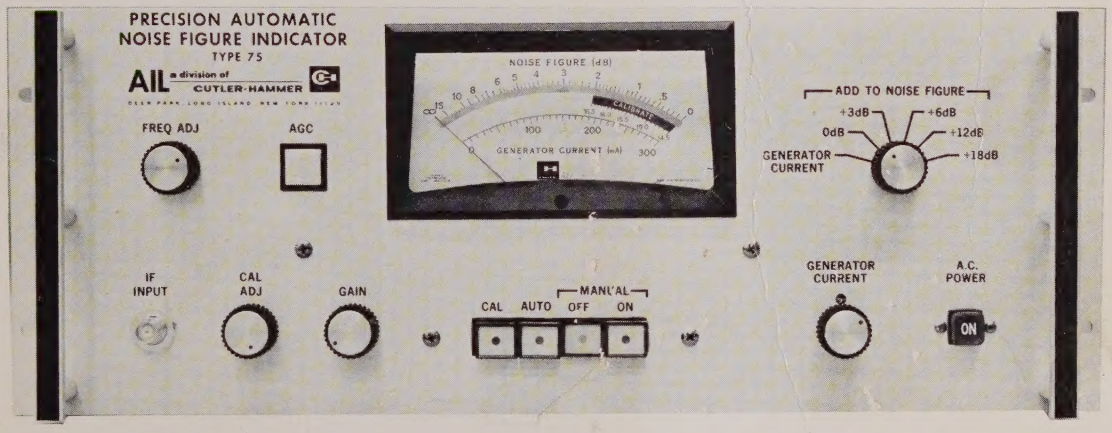
INSTRUCTION MANUAL FOR·····

NOTE THIS UNIT NEEDS ADDENDUM FOR REMOTE TURN OFF OF SOLID STATE NOISE GENS. FOR TEST SITUAT J.S

TYPE 75

Precision Automatic Noise Figure Indicator



75 Revision C

AIL a division of CUTLER-HAMMER CONTROL
FARMINGDALE, LONG ISLAND, NEW YORK 11735

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INSTRUCTION MANUAL FOR.....

TYPE 75

Precision Automatic Noise Figure Indicator

75 Revision C

AIL a division of CUTLER-HAMMER

FARMINGDALE, LONG ISLAND, NEW YORK 11735

WARRANTY

Except for tubes, fuses, and batteries which carry no warranty, Cutler-Hammer, in connection with equipment sold, agrees to correct any defect in workmanship or material which may develop during the period of one year from the date of shipment under proper or normal use and not in excess of the original manufacturer's life expectancy ratings, by its option to repair or replace, FOB point of shipment, the defective part or parts, and such correction shall constitute a fulfillment of all Cutler-Hammer liabilities in respect to said apparatus.

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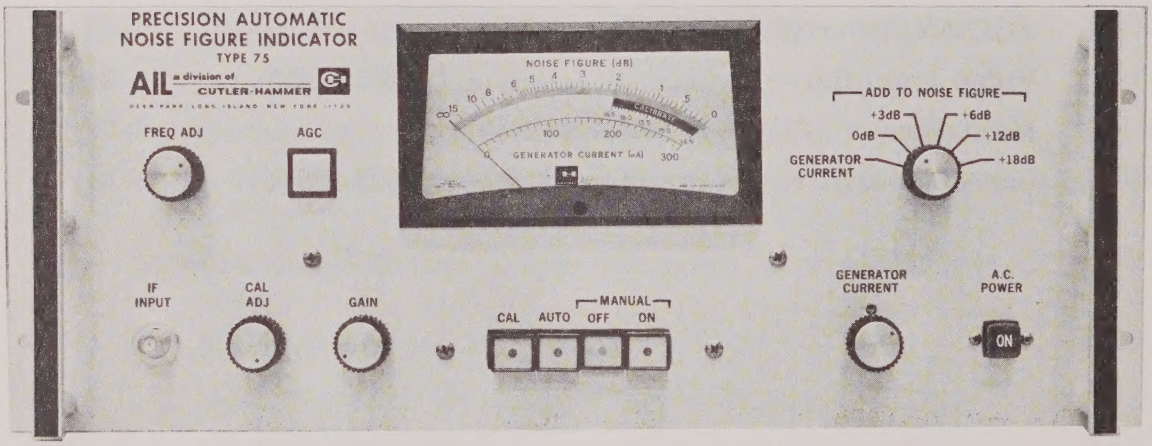


FIGURE 1-1. PRECISION AUTOMATIC NOISE FIGURE INDICATOR

SECTION I

INTRODUCTION

1.1 GENERAL

The AIL Type 75 Precision Automatic Noise Figure Indicator (PANFI), when used with an appropriate AIL Type 70 or Type 76 Noise Generator, provides a continuous and direct meter reading in dB of the noise figure of a device under test. AIL Type 70 Noise Generators, covering a 10 MHz to 40 GHz range, and Type 76 Solid State Noise Generators, covering a 10 MHz to 18 GHz range, are available for use with the AIL Type 75 Precision PANFI for automatic or manual noise figure measurement.

The continuous, accurate, indication of the noise figure of the device under test permits adjustment of the circuit parameters for minimum noise figure. The device under test may be a complete receiver (radar, telemetry, etc.), an amplifier (traveling-wave-tube type, reactance type, etc.) an IF amplifier, or a mixer-IF amplifier combination. The operational simplicity and extreme accuracy of indication makes the PANFI suitable for use in both laboratory and production facilities.

1.2 MODELS, OPTIONS, AND ACCESSORIES

1.2.1 MODELS

The Type 75 PANFI is available in three basic configurations. Each differs only in its noise generator power supplies. One noise generator power supply drives the Type 70 Gas-Discharge Noise Generator (Type 70 Gas Modulator), another power supply drives the Type 70 Solid State Noise Generator (Type 70 Solid State Modulator), and a third power supply drives the Type 76 Solid State Noise Generator (Type 76 Modulator). The last two

digits of the PANFI part number reflect the noise generator power supplies within the PANFI as follows:

PANFI P/N	NOISE GENERATOR POWER SUPPLIES
07510	Type 70 Gas Modulator and Type 70 Solid State Modulator
07511	Type 70 Gas Modulator and Type 76 Modulator
07512	Type 76 Modulator

1.2.2 OPTIONS

Standard options to the Type 75 PANFI usually satisfy various IF requirements. These options are denoted by a three-digit part number following the Type 75 part number, e.g. 07510-001. Among these options are:

-001 The P/N 07530 Tunable Converter which allows an IF input from 40 to 150 MHz, tunable from a front panel control. The P/N 07530 converter may also be installed in any Type 75 PANFI in the field.

-002 The P/N 07508 Broadband Converter supplies a tunable IF input from 10 to 1000 MHz with an external local oscillator (LO) and a 30-MHz fixed IF input not requiring an LO.

-003 (TV-75) IF input of 45.5 MHz with strong rejection of signals above the passband. Primarily intended for the television industry but applicable wherever an IF around 45.5 MHz is needed.

1.2.3 ACCESSORY NOISE GENERATORS

AIL provides a complete line of solid state and gas-discharge noise generators for use with the Type 75 PANFI.

The standard Type 76 Solid State Noise Generators, usable with the 07511 and 07512 PANFI are:

Noise Generator P/N	Frequency Range
07615	10 to 1500 MHz
07616	1.0 to 12.4 GHz
07617	12.4 to 18 GHz

The Type 70 Solid State Noise Generator, usable with the 07510 PANFI is:

07001	10 to 450 MHz

The Type 70 Gas-Discharge Noise Generators, usable with the 07510 and 07511 PANFI are:

07010, 07011	200 to 2600 MHz
07012	2 to 5 GHz
07048	2.6 to 3.95 GHz
07049	3.95 to 5.85 GHz
07050	5.85 to 8.2 GHz
07051	7.05 to 10.0 GHz
07052	8.2 to 12.4 GHz
07091	12.4 to 18.0 GHz
07053	18.0 to 26.5 GHz
07096	26.5 to 40.0 GHz

NOTE

The Type 70 Gas Modulator and the Type 76 Modulator are available in kits from the factory so that they may be easily installed in any Type 75 PANFI in the field. Contact the factory or your local sales representative for further information.

SECTION II

SPECIFICATIONS

2.1 TYPE 07510, 07511, AND 07512 SPECIFICATIONS

Noise figure ranges	0 to 33 dB in 5 ranges; scale to infinity on all ranges	
Full scale ranges	0, 3, 6, 12, and 18 dB	
Accuracy* (automatic mode)	0-dB range	0 to 3 ±0.15 dB 3 to 6 ±0.25 dB
	3-dB range	3 to 6 ±0.15 dB 6 to 9 ±0.25 dB
	6-dB range	6 to 9 ±0.15 dB 9 to 12 ±0.25 dB
	12-dB range	12 to 18 ±0.5 dB
	18-dB range	------- ±1.0 dB
AGC	65 dB	
Input sensitivity	-73 dBm (50 μV)	
Input frequency	30 MHz with a 5-MHz BW (minimum)	
Operating modes	Automatic, manual, and calibrate	
Input impedance	50 ohms (nominal)	
Gas-discharge noise generator power supply (07510, 07511)	Modular unit: may be removed for remote operation of gas-discharge noise generator (up to 1000 feet) Output current: 100 - 250 mA (adjustable from front panel) Ionization pulse: 5 kV (typical)	

* As compared to manual measurement (excluding noise source) using AIL Type 32 Precision Attenuator.

Diode gate output:	Synchronized trigger signal to permit operation of:
07510	Type 07001 Solid State Noise Generators
07511, 07512	Type 76 Solid State Noise Generators
Recorder output	50 mV dc (at full scale meter deflection); 5-kilohm output impedance, ungrounded
Operating temperature	0 to 50°C
Power required	115/230 V ac ±10%, 50 to 400 Hz 1 A/0.5 A
Weight	38 pounds
Size (Figure 2-1)	19-inches wide 20-1/8 inches deep 7-inches high

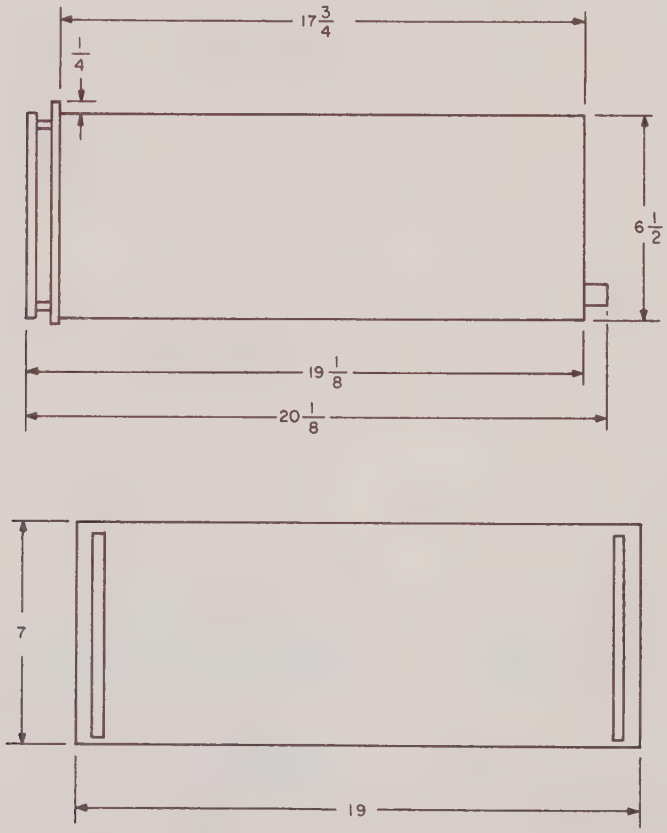


FIGURE 2-1. OUTLINE DRAWING

2.2 STANDARD OPTION SPECIFICATIONS

Standard options for 07510, 07511, and 07512 will give you all specifications exactly as stated in paragraph 2.1 except as noted below:

-001 (P/N 07530 Tunable Converter)

Input Sensitivity	-67 dBm (100 μV)
Input Frequency	40 to 150 MHz continuously tunable with a 4-MHz bandwidth (minimum)

-002 (P/N 07508 Broadband Converter)

Input Sensitivity	-67 dBm (100 μV) at variable (VAR) IF input
	-67 dBm (100 μV) at 30-MHz input
Input Frequency	10 to 1000 MHz tunable with an external local oscillator (not supplied) - 4-MHz bandwidth (minimum)
	30 MHz with a 5-MHz bandwidth (minimum), not requiring a local oscillator

-003

Input Sensitivity	-73 dBm (50 μV)
Input Frequency	45.5 MHz with a 6-MHz bandwidth (minimum) Strong rejection of signals above the passband

SECTION III

OPERATING CONTROLS, INDICATORS, AND CONNECTORS

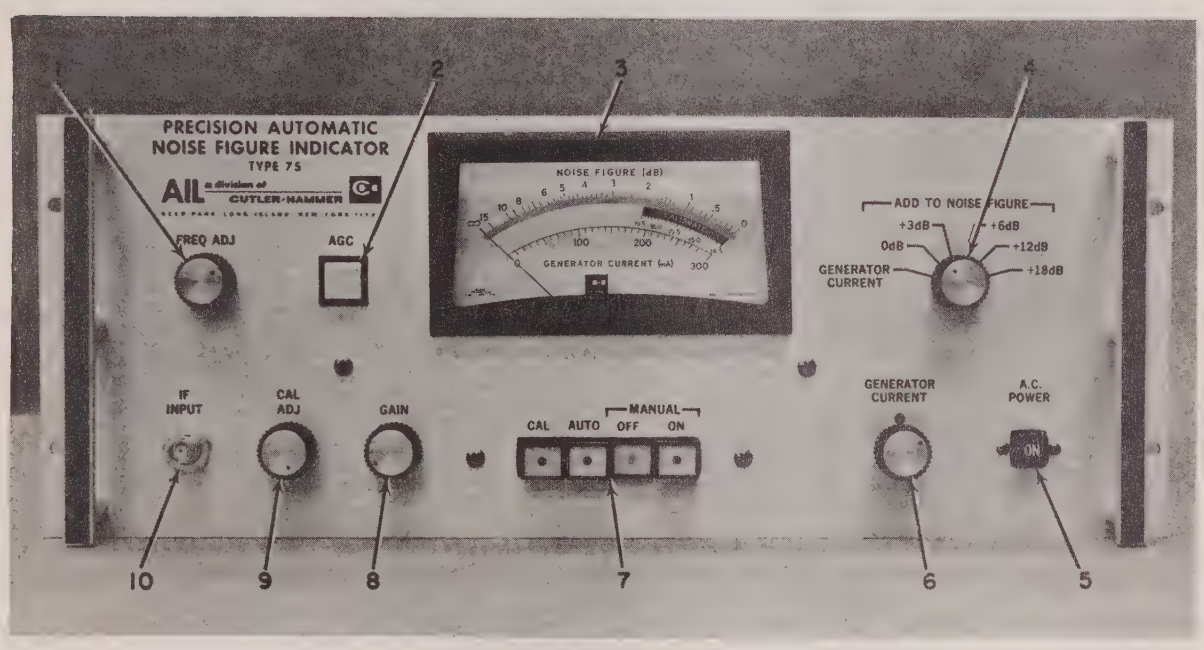


FIGURE 3-1. FRONT PANEL CONTROLS

Index No. (Figure 3-1, 3-2)	Description	Function
1	FREQ ADJ control	Adjusts frequency of tunable input (optional).
2	AGC indicator (DS901)	Indicates that input signal is above minimum level required for AUTO or CAL mode of operation.
3	Meter (M901)	Indicates noise figure, excess noise ratio, or gas-discharge noise generator current.
4	Scale selector (S902)	Selects desired noise figure scale or noise generator current scale.

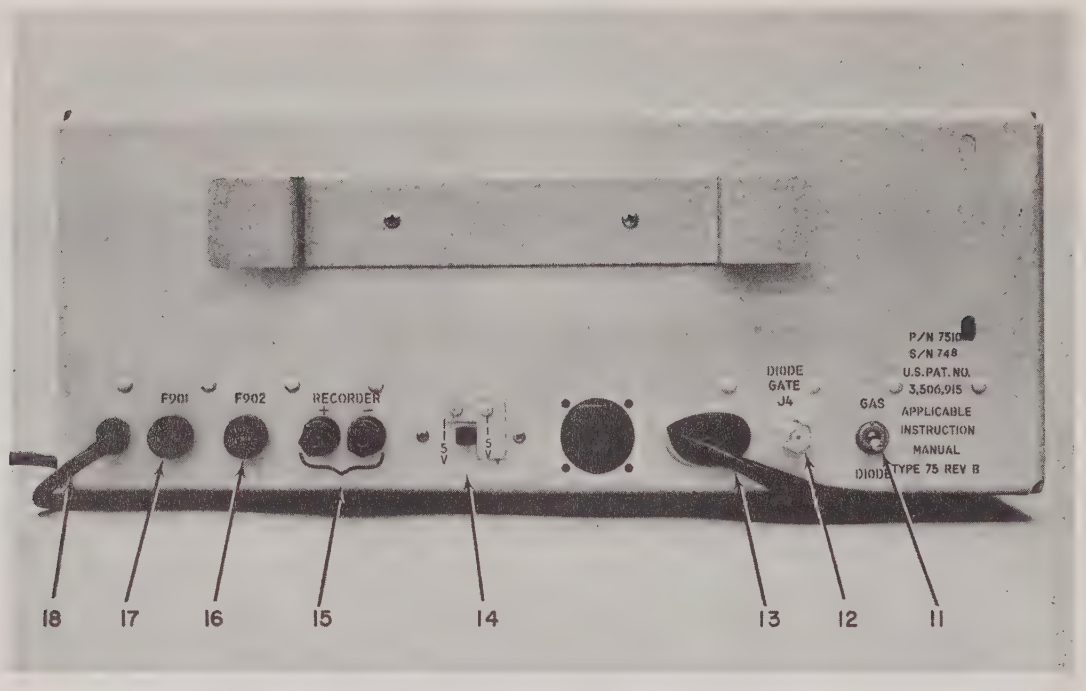


FIGURE 3-2. REAR PANEL CONTROLS

Index No. (Figure 3-1, 3-2)	Description	Function
5	AC POWER switch (S904)	Controls application of ac primary power.
6	GENERATOR CURRENT control (R902)	Adjusts gas-discharge noise generator current.
7	Selector switches (S901)	Select operating condition as indicated.
7a	CAL	Sets meter to read calibration of instrument to known excess noise ratio of external noise generator.
7b	AUTO	Sets meter to read automatic noise figure.
7c	MANUAL OFF	Converts instrument to total power receiver and turns noise generator off.

Index No. (Figure 3-1, 3-2)	Description	Function
7d	MANUAL ON	Converts instrument to total power receiver and turns noise generator on continuously.
8	GAIN control (R905)	Adjusts IF postamplifier gain during manual operation.
9	CAL ADJ control (R901)	Calibrates instrument to known excess noise ratio of external noise generator indicated on CALIBRATE meter scale.
10	IF INPUT connector (J3)	Input connector from device under test.
11	GAS-DIODE switch (S903)	Selects gas-discharge or diode noise generator being used; removes ignition pulse from anode connector when not in use.
12	DIODE GATE connector (J4)	Provides access to gate signal output for diode noise generator.
13	Cables (J5, J6)	Anode and cathode cables for connection to AIL Type 70 Gas-Discharge Noise Generators.
14	Input voltage selector switch (S905)	Changes unit for 115 or 230 V operation.
15	RECORDER connectors (BP901, BP902)	Output connectors for external recorder.
16	FUSE (F902)	Provides overload protection.
17	FUSE (F901)	Provides overload protection.
18	AC line cord (P901)	Provides connection for input ac power from line source.

SECTION IV

OPERATING INSTRUCTIONS

4.1 AUTOMATIC NOISE FIGURE MEASUREMENT USING GAS-DISCHARGE NOISE GENERATOR

To make an automatic noise figure measurement, using the gas-discharge noise generator, proceed as follows:

1. Connect the equipment as shown in Figure 4-1.

CAUTION

If an AIL 7010, 7011 or 7012 Coaxial Noise Generator is being used, observe the note at the end of this paragraph.

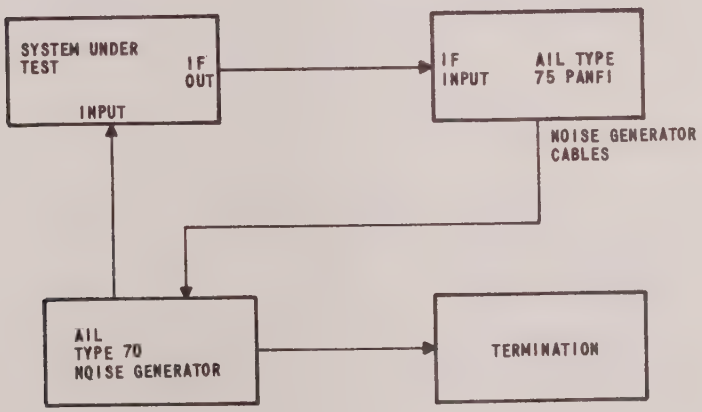


FIGURE 4-1. AUTOMATIC NOISE FIGURE MEASUREMENT USING GAS-DISCHARGE NOISE GENERATOR

2. Set GAS-DIODE switch to GAS position.

3. Set GENERATOR CURRENT control fully counter-clockwise.

4. Depress MANUAL OFF button.

5. Set scale selector to GENERATOR CURRENT.

6. Depress AC POWER button.

7. Depress MANUAL ON button and adjust GENERATOR CURRENT control for the meter current setting recommended in Table 4-1.

8. Depress CAL button and rotate the scale selector switch to any position except GENERATOR CURRENT; note that the AGC front panel indicator is illuminated. This indicates that the input signal is above the minimum required level. (If it is not, the gain of the device under test may be too low.)

9. While observing the CALIBRATE scale (green band) of the front panel meter, rotate the CAL ADJ control to obtain the appropriate excess noise ratio for the noise generator being used (Table 4-1).

10. After depressing the AUTO button, rotate the scale selector switch to obtain a convenient reading on the NOISE FIGURE scale of the front panel meter.

CAUTION

The AGC indicator must be on for all automatic noise figure readings; if it is not on, the gain of the device may be too low.

11. Read the noise figure (in dB) of the system under test, on the meter.

NOTE

(7010, 7011, 7012 Noise Generators)

A high-voltage pulse is required to ignite the noise lamp within these generators. Capacitive coupling between the anode of the lamp and the helical transmission line causes an attenuated sample of the ignition pulse to appear at the RF output ports. Even with one port terminated with a 50-ohm load, the amplitude of the pulse at the other port can be as high as 5 volts. If the device under test has a solid state front end, it should be protected from this pulse. A 3-dB attenuator between the noise generator output and the unit under test will usually suffice, although higher values of attenuation may be used if desired. The value of the attenuator (in dB) must then be subtracted from the measured value of noise figure (in dB) in order to obtain the true noise figure of the device under test.

4.2 AUTOMATIC NOISE FIGURE MEASUREMENT USING SOLID STATE NOISE GENERATOR

To make an automatic noise figure measurement using solid state noise generator, proceed as follows:

1. Connect equipment as shown in Figure 4-2.

CAUTION

The Solid State Noise Generators must be driven by their proper modulators for a correct noise figure reading. If uncertain of the diode gate (modulator) output, see paragraph 1.2.1.

TABLE 4-1. METER CURRENT SETTINGS

Generator	Excess Noise Ratio (ENR) (dB)	Tube Current (mA)
7001	See 7001 case	Not applicable
7010	15.65	175
7011	15.65	175
7012	15.75	175
7048	15.35	200
7049	15.60	175
7050	15.65	175
7051	15.75	175
7052	15.75	175
7053	16.15	150
7091	16.15	150
7096	16.30	100
7615	15.50	Not applicable
7616	15.50	Not applicable
7617	15.50	Not applicable

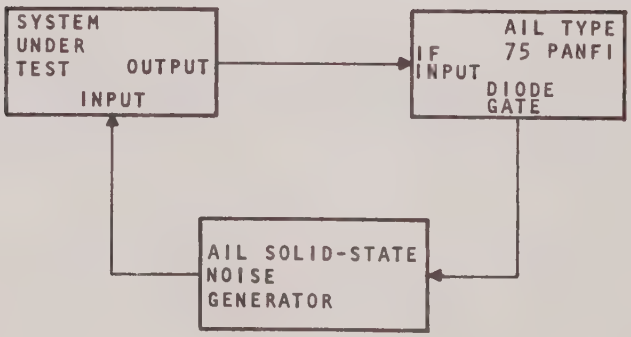


FIGURE 4-2. AUTOMATIC NOISE FIGURE MEASUREMENT USING SOLID STATE NOISE GENERATOR

2. Set the GAS-DIODE switch to the DIODE position.

3. Depress MANUAL OFF button.

4. Set scale selector to any convenient noise figure position.

5. Depress AC POWER button and the MANUAL ON button.

NOTE

A generator current control and a generator current monitor (meter) are not necessary for the Solid State Noise Generators and are not provided.

6. Depress the CAL button. The AGC light must be on. If it is not, the input signal to the PANFI is below the minimum level required.

7. Use the CAL ADJ control to set the front panel meter to the excess noise ratio (on the CALIBRATE scale, in dB) of the solid state noise source. The scale selector may be in any position except NOISE GENERATOR. The system is now calibrated.

8. Depress the AUTO mode button and set the scale selector for an on-scale meter reading.

CAUTION

The AGC indicator light must be on for all automatic noise figure readings.

9. Read the noise figure (in dB) of the device under test, on the meter.

4.3 MANUAL NOISE FIGURE MEASUREMENT (Y-FACTOR) USING GAS-DISCHARGE NOISE GENERATOR

To make the manual noise figure measurement (Y-factor) using a gas-discharge noise generator, proceed as follows:

1. Connect the equipment as shown in Figure 4-3.

CAUTION

If an AIL 7010, 7011 or 7012 Noise Generator is being used, observe the note at the end of paragraph 4.1.

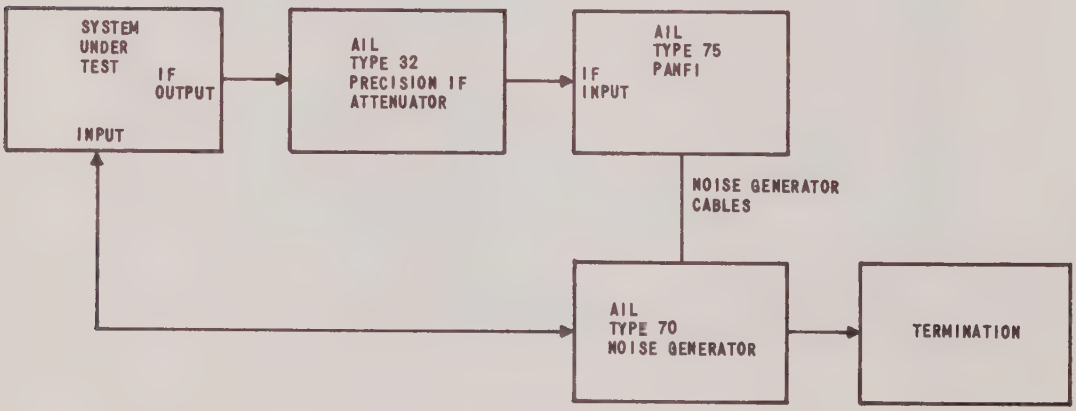


FIGURE 4-3. MANUAL NOISE FIGURE MEASUREMENT USING GAS-DISCHARGE NOISE GENERATOR

2. Set the GAS-DIODE switch to the GAS position.
3. Set the GENERATOR CURRENT control fully counterclockwise.
4. Depress the MANUAL OFF button.
5. Set the scale selector to GENERATOR CURRENT position.
6. Depress the AC POWER button.

7. Depress the MANUAL ON button and adjust the GENERATOR CURRENT control for the meter current setting recommended in Table 4-1.

8. Depress the MANUAL OFF button. The scale selector switch may be set to any position without affecting the accuracy of the manual measurement.

9. Adjust the GAIN control and the precision attenuator for a convenient meter reading.

NOTE

All attenuator settings should be obtained using counterclockwise rotation to eliminate backlash.

10. Note the meter reading and the precision attenuator setting.

11. Depress the MANUAL ON button and increase the precision attenuator setting until the meter returns to the setting noted in step 10.

NOTE

Do not disturb the GAIN control setting.

12. Subtract the attenuator reading in step 10 from that in step 11. This is the Y-factor (in dB).

13. To check for possible reading errors, depress the MANUAL OFF button and readjust the precision attenuator to obtain the meter reading noted in step 10. Note that the attenuator reads the same as in step 10.

The noise figure of the device under test can be computed from:

$$F = \frac{\frac{T_2}{T_o} - 1}{Y - 1}$$

where

T_2 = effective temperature of the noise generator in the ON condition.

T_o = 290°K (standard reference temperature).

Y = ratio of the noise output of the device under test with the noise generator ON to that with the noise generator OFF.

The noise figure (in dB) is given by:

$$F_{dB} = 10 \log \left(\frac{T_2}{T_o} - 1 \right) - 10 \log (Y - 1)$$

where $10 \log \left(\frac{T_2}{T_o} - 1 \right)$ is the excess noise ratio (ENR) of the noise generator (in dB). The ENR of the AIL Gas-Discharge Noise Generator being used may be found in Table 4-1.

In lieu of actual computation, the noise figure can be computed from either the AIL noise figure slide rule, or from Figure 4-4.

4.4 MANUAL NOISE FIGURE MEASUREMENT USING SOLID STATE NOISE SOURCE

To make a noise figure measurement (Y-factor) using the Solid State Noise Source, proceed as follows:

1. Set up the equipment as shown in Figure 4-5.

CAUTION

The Solid State Noise Generators must be driven by their proper modulators for a correct noise figure reading. If uncertain of the diode gate (modulator) output, see paragraph 1.2.1.

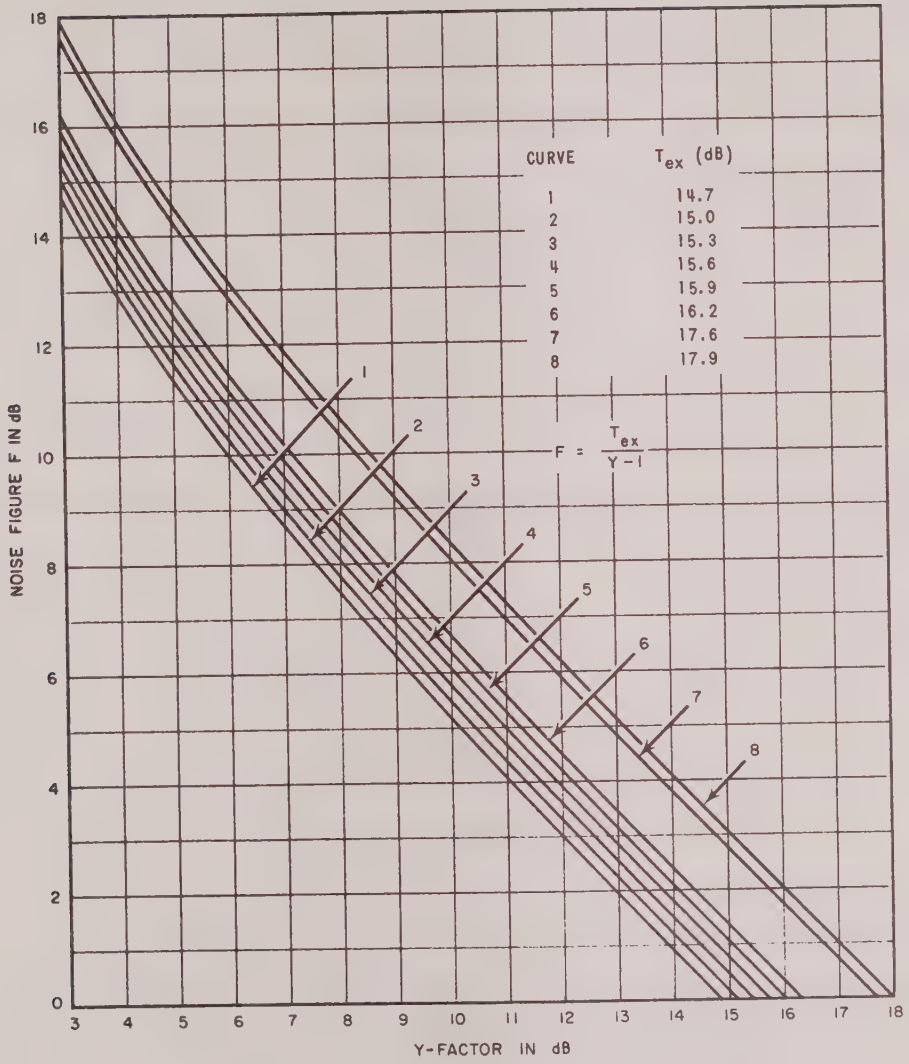


FIGURE 4-4. Y-FACTOR VS NOISE FIGURE

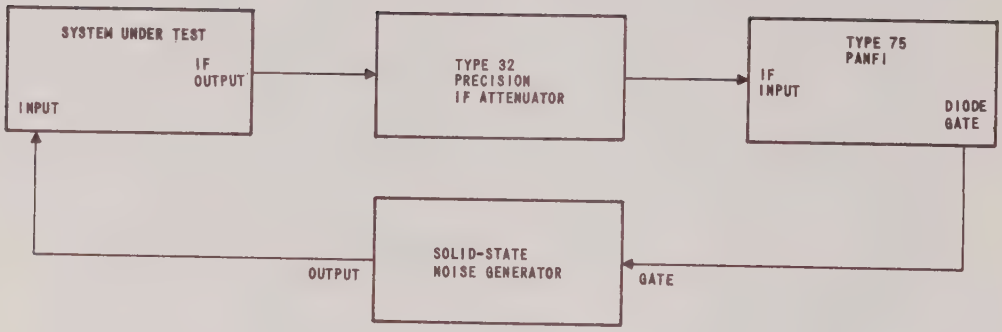


FIGURE 4-5. MANUAL NOISE FIGURE MEASUREMENT USING SOLID STATE NOISE GENERATOR

2. Set the GAS-DIODE switch to the DIODE position.
3. Depress the MANUAL OFF button.
4. Set the scale selector to the 0-dB position.
5. Depress the AC POWER button.

NOTE

A generator current control and a generator current monitor (meter) are not necessary for the Solid State Generators and are not provided.

6. Adjust the GAIN control and the precision attenuator for a convenient reference reading on the PANFI meter.
7. Note the attenuator reading.
8. Depress the MANUAL ON button.

9. Increase the precision attenuator setting until the PANFI meter returns to the reference noted in step 6. Note this attenuator reading.

10. Subtract the attenuator reading in step 7 from that in step 9; this is the Y-factor (in dB).

To check for possible reading errors, depress the MANUAL OFF button and readjust the attenuator to obtain the same reading noted in step 6 on the PANFI meter. The noise figure of the device under test can be computed by the methods described in paragraph 4.3. The ENR of AIL Solid State Noise Generators is indicated on the noise generator case.

4.5 MANUAL Y-FACTOR MEASUREMENTS USING THE AIL TYPE 75 CALIBRATED OUTPUT INDICATOR

When a manual Y-factor measurement is desired and an AIL Type 32 Precision Attenuator is not available, the calibrated output indicator of the Type 75 PANFI may be used. The accuracy of the measurement will be within 0.4 dB for most situations. To make the measurement perform the procedures listed in the following steps.

1. Set up the equipment as shown in either Figure 4-1 or 4-2 as applicable.

2. Depress the MANUAL OFF button.

3. Set the GAS-DIODE switch to either DIODE or GAS depending upon which type of noise source is being used.

4. Set the scale selector to the 0-dB position.

5. Depress the AC POWER button.

6. If an AIL Solid State Noise Source is being used, depress the MANUAL ON button.

7. If the AIL Type 70 Gas-Discharge Noise Generator is being used, depress the MANUAL ON button and set the scale selector to GENERATOR CURRENT position. Adjust the GENERATOR CURRENT control for the meter current shown in Table 4-1.

8. Set the scale selector to the 0-dB position and adjust the GAIN control for full scale meter reading (0 dB).

9. Depress the MANUAL OFF button and change the scale selector for a convenient meter reading.

10. Add the scale selector reading to the meter reading (in dB) to obtain the Y-factor.

The noise figure of the device under test can be computed using the method discussed in paragraph 4-3.

4.6 INSTALLATION AND OPERATION OF THE 07530 CONVERTER WITH THE TYPE 75 PRECISION ANFI (OPTIONAL)

The 07530 Converter is available as an accessory to the AIL Type 75 PANFI. When this converter is used, the Type 75 PANFI can be used to test systems with output frequencies between 40 and 150 MHz.

4.6.1 INSTALLATION OF THE CONVERTER

The Type 07530 Converter is shown installed in the PANFI in Figure 4-6. The installation procedure is as follows:

1. Slip the converter tuning shaft through the front panel bushing and secure it to the subchassis with the six screws provided. Attach the tuning knob provided.

2. Disconnect the input cable from J1 on the IF post amplifier detector located under the main chassis.

3. Thread this cable through the large hole in the front of the main chassis and connect it to the input jack on the side of the converter.

4. Thread the converter output cable back through the same hole and connect it to J1, the postamplifier detector input jack.

5. These are two power connections for the converter. The black wire is ground; connect it to terminal 6 on the modular power supply at the rear of the unit. The other lead is the 20-volt dc line; connect it to terminal 5 of the modular supply. The terminals on this power supply are numbered 1 through 8 starting from the bottom.

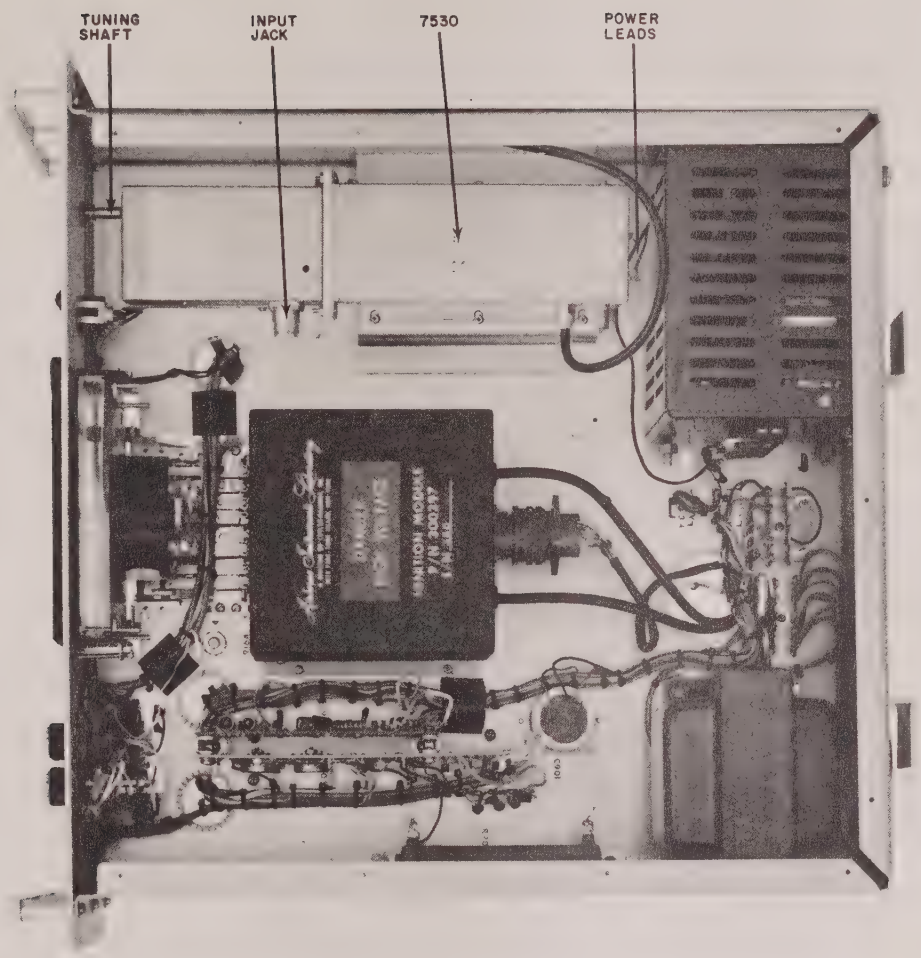


FIGURE 4-6. PANFI WITH CONVERTER INSTALLED

4.6.2 OPERATION

1. Connect a signal generator to the front panel IF INPUT jack on the PANFI.
2. Depress the MANUAL OFF button.
3. Set scale selector to 0-dB range.
4. Depress AC POWER button.
5. Set the signal generator to the desired frequency of operation (between 40 and 150 MHz) and adjust its output to approximately -40 dBm.
6. Set the GAIN control to approximately mid-position.

7. Adjust FREQ ADJ control for a maximum reading on the front panel meter. If necessary, increase or decrease the GAIN control for an on-scale reading.

8. The Type 75 Precision ANFI is now ready for measurement at the desired frequency.

4.7 OPERATION OF THE 07508 BROADBAND CONVERTER WITH THE TYPE 75 PRECISION ANFI (OPTIONAL)

4.7.1 INTRODUCTION

The 07508 Broadband Converter enables the Type 75 PANFI to accept input signals from 10 to 1000 MHz. An external local oscillator (LO) is required to drive the converter. The IF of the broadband converter is 30 MHz. A 30-MHz front panel IF input allows input signals from 25 to 35 MHz to bypass the converter, thus eliminating the need for an LO.

The PANFI with the 07508 Converter has three inputs (LO, VAR, and 30 MHz) located on the left side of the front panel. These inputs function as follows:

- LO INPUT - Input to the broadband converter from the external local oscillator. An LO input is required whenever the broadband converter is used. In a typical noise figure measurement setup (Figure 4-7), if the output frequency of the device under test (DUT) is between 10 and 25 MHz or 35 and 70 MHz, the local oscillator should be set 30 MHz above the DUT output frequency.

  If the DUT output signal is between 70 and 1000 MHz, the LO frequency may be set 30 MHz above or below that signal frequency. The LO input power level should be 5 milliwatts (+7 dBm) whenever the broadband converter is used. A useful procedure for setting the LO frequency is explained in the last paragraph of this section.

- VAR INPUT - Signal input to the broadband converter from the device under test. It is used as the input to the PANFI from the DUT whenever the DUT frequency is between 10 and 25 MHz or 35 and 1000 MHz. It must be accompanied by an appropriate LO signal at the LO input.

- 30 MHz INPUT - Used when the output frequency of the device under test is from 25 to 35 MHz. This input goes directly to the 30-MHz postamplifier, bypassing the broadband converter, and therefore not requiring a local oscillator.

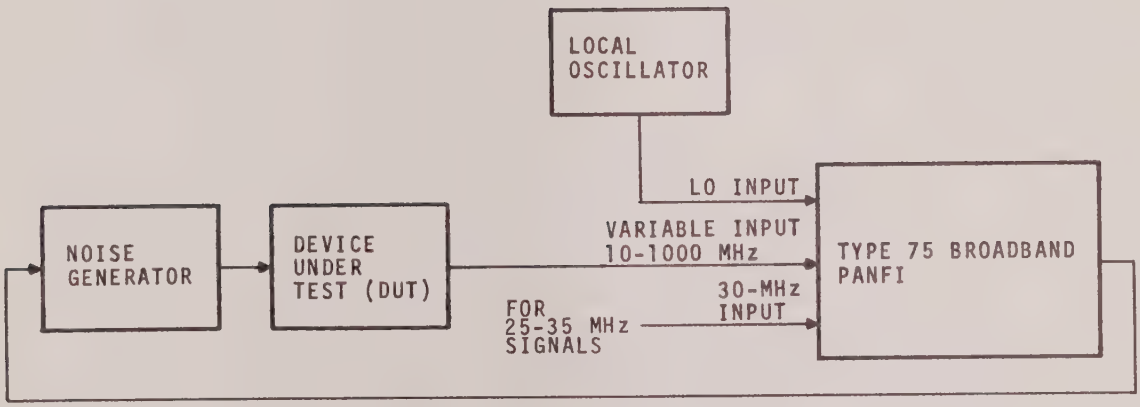


FIGURE 4-7. TYPICAL BROADBAND NOISE FIGURE MEASUREMENT SETUP

All operating instructions with regard to automatic and manual noise figure measurements as given in paragraphs 4.1 to 4.5 are applicable to the broadband PANFI except for consideration of the output frequency of the device under test. These considerations are summarized in Table 4-2.

TABLE 4-2. BROADBAND CONVERTER OPERATION

Device Under Test Output Frequency (f_c)	Signal Input To PANFI		LO Required at LO input	Input Sensitivity at Signal Port (for AGC lock-in "AUTO" mode)
	30 MHz port	VAR port		
10 to 25 MHz		X	+7 dBm at f_c + 30 MHz	-67 dBm
25 to 35 MHz	X		None	-67 dBm
35 to 70 MHz		X	+7 dBm at f_c + 30 MHz	-67 dBm
70 to 1000 MHz		X	+7 dBm at f_c ±30 MHz	-67 dBm

CAUTION

There is no image rejection using the broadband converter. If the device under test is broadband, with greater than 60-MHz bandwidth, the image (frequency) response will be part of the indicated noise figure and should be accounted for as outlined in paragraph 4.10.4

A simple, but accurate, method of obtaining the precise local oscillator frequency uses the PANFI as a receiver; thus adjustment of the local oscillator frequency for a peak or maximum signal would indicate correct LO frequency. This is accomplished by having both inputs connected to the PANFI; the DUT signal at the VAR INPUT at a convenient level between -67 and -5 dBm, LO at the LO INPUT with the LO at its proper power level and within several MHz of its desired setting. The PANFI should be in the MAN OFF mode. The meter should display an on-scale reading, which may be obtained by adjustment of the manual GAIN control on the front panel. By adjusting the LO frequency back and forth, a peak meter reading is obtained

which indicates correct LO frequency. This insures that the PANFI is seeing the desired response of the device under test.

4.7.2 OPERATION

4.7.2.1 SIGNALS 10 TO 25 MHz OR 35 TO 1000 MHz

1. Connect the equipment as shown in Figure 4-1, 4-2, 4-3, or 4-5 as applicable, using the VAR input of the PANFI as the IF input port.
2. Connect the local oscillator to the LO INPUT. Set the LO power level +7 dBm (5 mW) at the proper frequency as explained in paragraph 4.7.1 and summarized in Table 4-2.
3. The Type 75 PANFI is now ready for measurement at the desired frequency.

4.7.2.2 SIGNALS BETWEEN 25 AND 35 MHz

1. Connect the equipment as shown in Figure 4-1, 4-2, 4-3, or 4-5 as applicable, using the 30-MHz input of the PANFI as the IF input.
2. The Type 75 PANFI is now ready for measurement at the desired frequency.

4.8 OPERATION WITH FIXED IF INPUT OTHER THAN 30 MHz (OPTIONAL)

A fixed IF frequency other than 30 MHz does not affect any of the operating instructions in paragraphs 4.1 through 4.5.

4.9 REMOTE OPERATION OF NOISE SOURCES

4.9.1 SOLID STATE

The Solid State Noise Generators may be operated at distances up to 1000 feet from the PANFI directly from the diode gate output. No changes or modifications are required.

4.9.2 GAS

The gas-discharge noise generator ignition module can be removed from the main chassis when it is desired to operate a gas-discharge noise source at a location up to 1000 feet away. This is accomplished as follows:

1. Disconnect J701 from the ignition module and mount the connector in the hole provided at the rear of the main chassis.
2. Remove the four screws holding the ignition module to the main chassis and lift the unit, with its two attached cables, out of the PANFI. Mount the ignition module at the desired location.
3. The interconnecting cable is not supplied and must be fabricated by the user. The PANFI end of the cable is terminated with an MS-3106A-18-8P connector; the ignition module end with an MS-3101A-18-8S. These connectors are not supplied with the equipment. Pin connections are as indicated in Figure 6-16. Suitable MS clamps should be used on the connectors for cable strain relief. The wire size should be AWG 20 or greater.

Four wires are required in the cable, one of which is ground. The line connected to pin E of J701 carries the trigger pulse. This line should be individually shielded to prevent spurious triggering of the ignition module. Pin C is the noise generator cathode return. In the automatic mode of operation the signal on this line is a high level (300 volt p-p) 400-Hz square wave. If the surrounding equipment is sensitive to interference, it would be advisable to shield the entire cable.

Remote operation of a noise source does not affect any of the operating procedures.

4.10 CONVERTING FROM 115- TO 230-VOLT OPERATION

When delivered, the Type 75 PANFI is wired for 115 V, unless 230 V appears on the back panel at the voltage switch (14 of Figure 3-2). To convert the Type 75 PANFI, remove the plate on the rear panel covering the voltage switch and change the position of the switch so the 230 V will appear when the plate is replaced. Replace the plate after switching. The 1.5 amp fuses (115 volt operation) should be replaced by 0.75 amp fuses for 230 volt operation.

4.11 ACCURACY CONSIDERATIONS

4.11.1 NOISE GENERATOR ERROR AND CALIBRATION

Noise figure measurements assume an accurate knowledge of ENR, the excess noise ratio of the noise source being used. In general, the noise power output is not constant over the entire operating frequency range or the same for all noise generators, gas-discharge or solid state.

In the case of gas-discharge noise generators, the excess noise ratio is a function of various physical characteristics of the tube, and of the coupling of the microwave structure to the discharge. The production tolerance of the tubes is ±0.25 dB with an uncertainity on the center value of ±0.2 dB. The coupling of the microwave structure to the discharge is related to the fired and unfired insertion loss of the gas-discharge noise generator. Figure 4-8 shows the effect of these insertion losses on the excess noise ratio of the noise generator.

In the case of solid state noise generators, the excess noise ratio is a function of the semiconductor fabrication, the coaxial mount, and the bias (power supply). AIL Type 76 Solid State Noise Generators are designed for constant noise power outputs across their frequency bands. They exhibit less than ±0.5 dB (maximum) deviation from a constant ENR of 15.5 dB across their specified frequency spectrums. The precision modulator in the Type 75 PANFI, which drives the AIL Type 76 Solid State Noise Sources, keeps changes in ENR due to bias below ±0.005 dB.

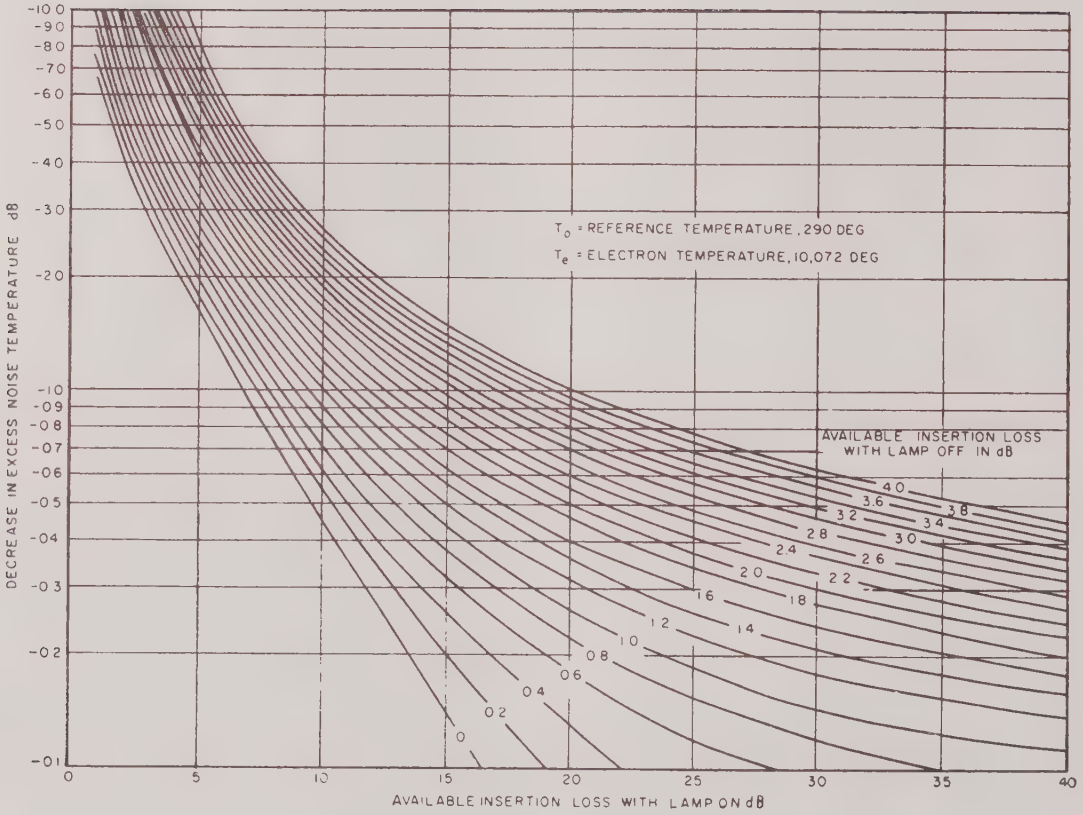


FIGURE 4-8. DECREASE IN RELATIVE EXCESS NOISE TEMPERATURE AS A FUNCTION OF NOISE SOURCE INSERTION LOSS

Any uncertainty in the ENR of a noise generator will cause a direct uncertainty in the noise figure measured, and should be taken into account when computing the total accuracy of a noise figure measurement whether manual or automatic. When greater accuracy than is normally obtained is required, AIL can calibrate gas-discharge and solid state noise generators to uncertainties as low as ±0.11 dB at specific frequencies with traceability to the National Bureau of Standards (NBS). This is accomplished by the AIL Noise Generator Calibration Facility which uses the AIL Type 82 Noise Calibration System. This system is capable of comparing the output of a noise generator to NBS calibrated noise standards, such as AIL Type 80 Noise Standards, to within ±0.05 dB. Consult with the factory or your local sales representative for further information.

4.11.2 NOISE GENERATOR TERMINATION TEMPERATURE

The definition of noise figure is based on a termination temperature of 290°K (the reference temperature). If this condition is not met, the measured value of noise figure must be corrected. This correction (δ) in dB, determined from Figure 4-9 or equation 4-1, is algebraically added to the measured noise figure (also expressed in dB).

$$\delta = 10 \log \left[1 - \frac{T_1 - T_0}{T_2 \quad T_2} - \frac{T_1 - T_0}{T_0 \quad F_m} \right] \qquad (4\text{-}1)$$

where

T_1 = actual temperature of the termination

T_2 = effective temperature of the noise generator in the ON condition

T_0 = 290°K

F_m = measured noise figure

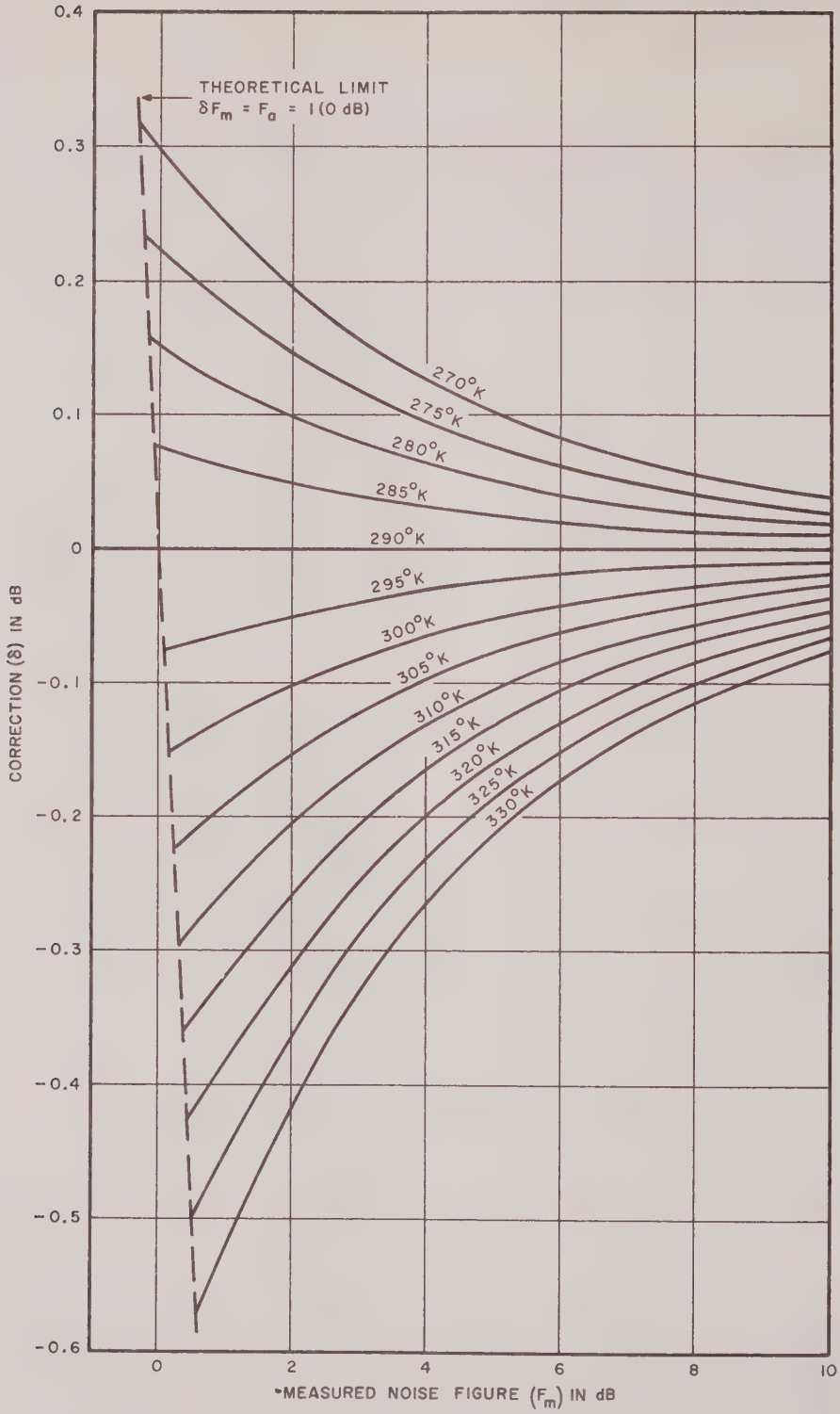


FIGURE 4-9. EFFECT OF TERMINATION TEMPERATURE NOT EQUAL TO 290°K FOR NOISE GENERATOR WITH NOMINAL 15.3-dB EXCESS NOISE RATIO

4.11.3 SWR DIFFERENTIAL

The difference in SWR of the noise generator between the hot (or ON) condition and cold (or OFF) condition may have a significant effect upon the gain and noise figure of some high-gain, negative-input-resistance devices (parametric amplifiers, masers, etc.). The change in gain due to source impedance variations for high-gain amplifiers (greater than 15 dB) can be closely approximated by:

$$\frac{\Delta G}{G} \approx \frac{\Delta |Z_o|}{|Z_o|} G^{1/2} \qquad (4\text{-}2)$$

where

G = amplifier gain

Z_o = source impedance

ΔG = change in gain

ΔZ_o = change in source impedance

This change in gain will cause an error in the MANUAL or AUTO method of measurement. The true Y-factor can be obtained from:

$$Y_{true} = Y_{measured\ (dB)} - \Delta G_{dB} \qquad (4\text{-}3)$$

ΔG can be measured exactly by coupling a test signal into the amplifier input through a 20- or 30-dB directional coupler and observing the output as the noise generator is turned on and off. The test signal power should be at least 20 dB greater than the noise power at the amplifier input, but not large enough to cause limiting in the system.

A second solution would be to provide isolation, by means of a ferrite device, between the amplifier input and the noise source. This would reduce the impedance variation seen by the amplifier. The insertion loss of the isolator would add directly (in dB) to the noise figure of the device under test.

The uncertainty in the measured noise figure, due to changes in the noise performance of the device under test caused by mismatch changes in the noise source, can be estimated by

$$dF_{dB} = \pm \frac{4.34 \frac{dM}{M}}{1 - \frac{1}{Y}} \tag{4-4}$$

where

$$\frac{dM}{M} = \frac{(1 + |\Gamma_r| \ |\Gamma_1|)^2}{1 - |\Gamma_r| \ |\Gamma_2|^2} - 1 \tag{4-5}$$

where

Γ_r = reflection coefficient of device under test

Γ_1 = reflection coefficient of noise generator in OFF condition

Γ_2 = reflection coefficient of noise generator in ON condition

4.11.4 IMAGE RESPONSE

The following applies only to conventional receiver applications in which the image channel is not normally used to convey information. Image response can be an important factor in the measurement of low-noise

systems consisting of a wideband preamplifier followed by a heterodyne receiver. If the preamplifier has nearly equal gain at both the image frequency and the signal frequency, its noise figure will be deteriorated by the amplification of the input noise at the image frequency and a manual Y-factor or automatic noise figure reading will not yield the true noise figure. Equation 4-6 shows the relation between the true noise figure (F_T) and the noise figure measured either manually or automatically.

$$F_T = \left(1 + \frac{G_{im}}{G_{sig}} \right) F_m \qquad (4\text{-}6)$$

where

F_T = true noise figure

F_m = noise figure measured

G_{im} = image channel gain

G_{sig} = signal channel gain

It can be seen that, for a receiver with equal signal and image channel gain, the measured noise figure will be one-half (or 3 dB below) the true noise figure.

4.11.5 CABLE LOSS

Any loss introduced between the noise generator and the device under test will cause an apparent change in the excess noise ratio of the generator. These losses should be measured accurately and subtracted (in dB) from the ENR of the generator. This corrected ENR should be used when setting up during the calibration mode of operation, or in the calculations for a manual measurement.

4.11.6 SYSTEM BANDWIDTH

The system bandwidth of a noise figure measuring setup includes the instrument making the measurement, as well as the device under test. Therefore, if an amplifier with a 5-MHz bandwidth were measured with an instrument having a 1-MHz bandwidth, the result will, in general, be an optimistic (or low) noise figure reading. With this condition, it is necessary to make several measurements so as to have measured the spot noise figure of the device under test completely across its band of operation. These numbers are then averaged to give the true noise figure. This error can be eliminated by using an instrument with a bandwidth equal to, or wider than, the device under test.

4.11.7 SECOND STAGE CONTRIBUTION

The equation for the overall noise figure of a two-stage device is

$$F_{12} = F_1 + \frac{F_2 - 1}{G_1} \qquad (4\text{-}7)$$

where all terms are in power ratios, and

F_1 = noise figure of the first stage

F_2 = noise figure of the second stage

F_{12} = overall noise figure of the two stages

G_1 = power gain of the first stage

A common error, when making a manual Y-factor measurement as described in paragraphs 4.3, 4.4, and 4.5, is to attempt to make a correction for the insertion loss of the attenuator and the noise figure of the following unit; this is incorrect.

The correct noise figure in a manual Y-factor measurement is given by equation 4-8.

$$F = \frac{ENR}{Y - 1} + \frac{1}{G_1} \qquad (4\text{-}8)$$

where

F = the noise figure of the device under test

Y = the Y-factor

G_1 = gain of the system preceding the attenuator

ENR = excess noise ratio of the noise generator being used

REFERENCES

1. "IRE Standards on Electron Tubes: Definition of Terms, 1962," (62 IRE 7.S2), Proc IEEE, Vol 51, No. 3, p 434-435, March 1963.
2. "Description of Noise Performance of Amplifiers and Receiving Systems," IRE Subcommittee 7.9 on Noise Proceedings of the IEEE, Vol 51, No. 3, p 436-442, March 1963.
3. R. L. Sleven, "A Guide to Accurate Noise Measurement," Microwaves, July 1964.
4. W. E. Pastori, "New Equation Analyses Mismatch Errors in Noise Measurements," Microwaves, April 1968.

SECTION V

THEORY OF OPERATION

5.1 FUNCTIONAL OPERATION

5.1.1 NOISE FIGURE

Noise figure can be defined as the ratio of the noise power available at the output of a network, when the input termination is at the standard reference temperature (T_o = 290°K), to that which would be available at the output of an ideal noiseless network of otherwise identical characteristics. This can be expressed mathematically as in equation 5-1.

$$F = \frac{N_o}{GN_i} \tag{5-1}$$

By rearranging equation 5-1,

$$N_o = N_i FG \tag{5-2}$$

The noise power available at the input is that generated by the input termination and can be written.

$$N_i = KT_oB \tag{5-3}$$

where

K = Boltzmann's constant = 1.38×10^{-23} joules/°K

B = bandwidth in Hz

T_o = standard reference temperature (290°K)

NOTE

All temperatures in these equations are expressed as absolute temperatures (degrees Kelvin) and are related to the Centigrade scale as follows:

$$^{o}K = ^{o}C + 273$$

Substituting in equation 5-2,

$$N_o = KT_oBFG \qquad (5\text{-}4)$$

Expansion of this relation yields

$$N_o = \left[KT_oB + (F - 1)\, KT_oB\right] G \qquad (5\text{-}5)$$

Although equation 5-5 expresses noise figure implicity in terms of its effect on the network output, it is sometimes considered more basic than equation 5-1 because:

- It can be used to show the effect of an input termination temperature differing from the reference temperature (T_o).
- It can be conveniently represented pictorially.
- It provides the basis for an indirect, but convenient, method of measuring noise figure.

Figure 5-1A is a representation of equation 5-5. Noise source A is the input termination. In addition, noise source B is a fictitious source that represents the network's contribution to the noise output, referred to the input. It should be noted that the definition of noise figure is based on the reference temperature. The effect of varying input termination temperature was discussed previously.

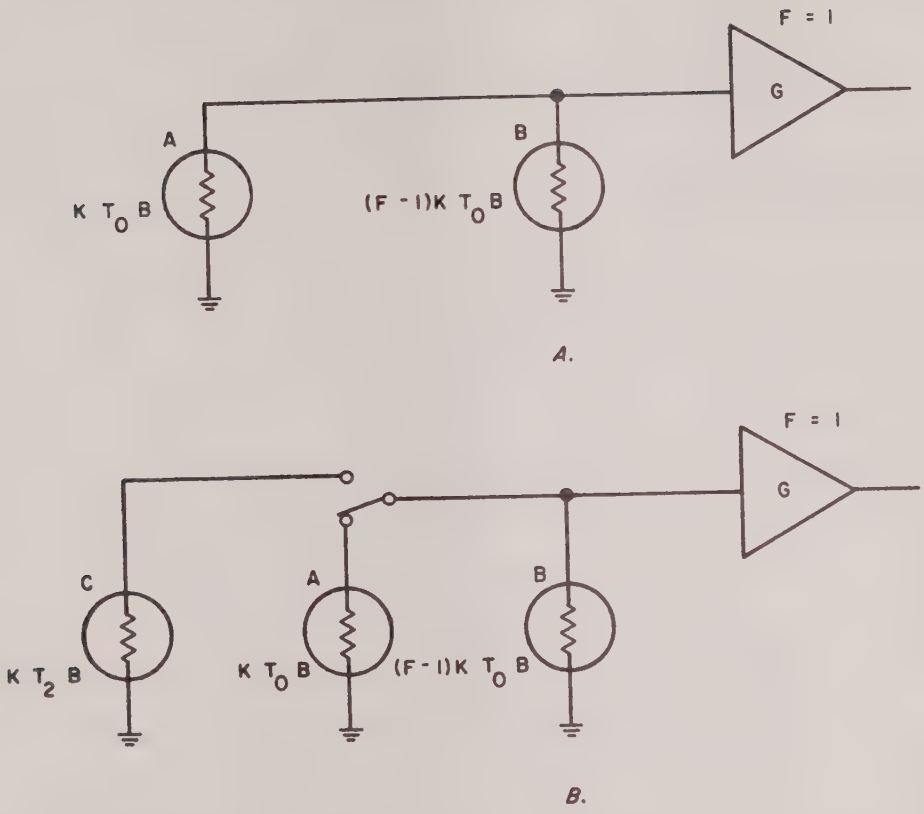


FIGURE 5-1. EQUIVALENT NOISE REPRESENTATION OF A NOISY NETWORK

5.1.2 NOISE FIGURE MEASUREMENT (GENERAL)

Figure 5-1A can be modified as indicated in Figure 5-1B. A switch is added, so that the original input termination (A) can be disconnected and the network input terminated in a second source (C) at a temperature

T_2 (the temperature of the gas-discharge noise generator usually). The available output power of the network for this condition is given by equation 5-6.

$$N_o = \left[KT_2B + KT_oB\,(F - 1)\right] G \tag{5-6}$$

Dividing equation 5-6 by equation 5-4

$$\frac{N_{o2}}{N_{o1}} = \frac{T_2 + T_o\,(F - 1)}{T_oF} \tag{5-7}$$

Adding -1 to both sides and rearranging terms,

$$F = \frac{\left(\frac{T_2}{T_o} - 1\right)}{\left(\frac{N_{o2}}{N_{o1}} - 1\right)} \tag{5-8}$$

Equation 5-8 is the basic relation for determining noise figure. The term $T_2/T_o - 1$ is called "excess noise ratio" and is usually expressed simply as ENR or T_{ex}. It represents the relative increase in noise power at the network input when the switch is operated. If T_{ex} is known, the ratio N_{o2}/N_{o1} (commonly called Y-factor) can be measured and the noise figure computed from equation 5-8. Note that it is not necessary to measure the absolute power levels at the network output, merely their ratio.

Therefore,

$$F = \frac{T_{ex}}{Y - 1} \tag{5-9}$$

5.1.3 MANUAL NOISE FIGURE MEASUREMENT

There are several methods of measuring Y-factor and, indirectly, noise figure. However, only the most common method is discussed.

Figure 5-2 is a block diagram showing the basic setup of equipment. The noise generator can be any one of a number of devices of known excess noise ratio. The most common are: (1) the gas-discharge lamp, in which the excess noise ratio is primarily a function of the type of gas, the diameter of the discharge column, and the gas pressure, and (2) the new solid state noise generators, such as the AIL Type 76 series. When the noise generator is turned off, the input of the receiver under test sees a passive termination at T_o and the detector level meter indicates some value indicative of N_{o1} in equation 5-8. When the noise generator is turned on, the output level will increase because of the increase of noise at the input. This new level is indicative of N_{o2}. If the attenuation between the receiver output and the detector is increased until the detector level is the same as with the noise source off, then this increase is the Y-factor (N_{o2}/N_{o1}) expressed in dB (assuming the attenuator is calibrated in dB). This value can then be converted to a power ratio, substituted in equation 5-9, and the receiver noise figure computed.

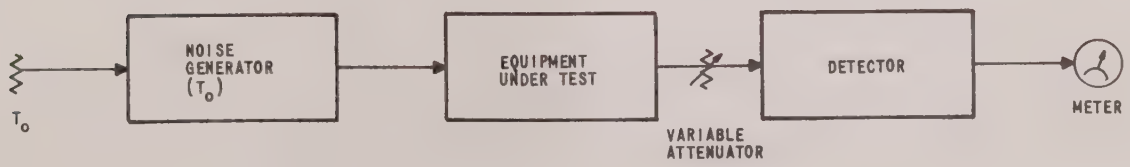


FIGURE 5-2. BLOCK DIAGRAM OF EQUIPMENT SETUP FOR DETERMINING NOISE FIGURE

This method of noise figure measurement is preferred because:

- The signal level entering the detector (usually a test receiver such as the AIL Type 136 Receiver or Type 75, in the manual mode) is kept at a constant level. Nonlinearities, the detector law, etc., are all held constant. In fact, the receiver may be operated in a nonlinear, or partially saturated condition. The only effect this has upon the measurement is a reduction in the resolution of the meter.
- The noise figure of the detector (or receiver) and the insertion loss of the attenuator make no contribution to the noise figure of the device under test. Again, the only effect a high insertion loss and high receiver noise figure has upon the measurement is a loss of resolution.
- If the meter change was read (in dB or any convenient ratio) instead of keeping its level constant, then the system must be checked very accurately for nonlinearities. Also, the meter must be calibrated over the range it is expected to operate.

5.1.4 AUTOMATIC NOISE FIGURE MEASUREMENTS

The preceding paragraphs derived the procedure for performing manual noise figure measurements. It is evident that, if a large number of measurements are required, or if the noise figure is being used as a measure of system performance while the system is being tuned or set up, these methods can become quite cumbersome and time consuming. The basic elements of the Precision Automatic Noise Figure Indicator are shown in general block form in Figure 5-3.

The first requirement for this type of system is a method of periodically turning the noise generator on and off. This is accomplished by a modulator driven by a gate generator, usually a free running square-wave generator (multivibrator) operating at a low audio frequency. The output of the receiver consists of square-wave modulated noise. As in the manual measurement, the two levels of this square wave represent the

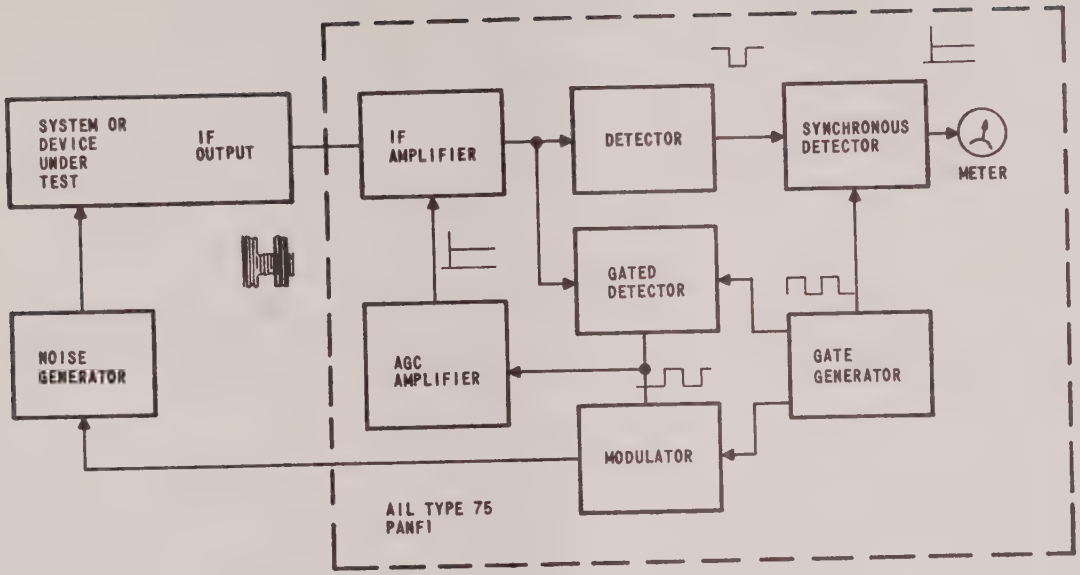


FIGURE 5-3. BLOCK DIAGRAM OF TYPE 75 PANFI

device-under-test (DUT) noise and the DUT plus generator noise. This signal is amplified in the IF amplifier and detected in a square-law detector. A sample of this modulated noise signal is also detected in a second detector which is gated to provide an output only during the time the noise generator is turned off. When the noise generator is turned on, the detector is gated off. Its output is then converted to a dc signal proportional to this noise-off condition. This dc signal is then amplified and applied to the IF amplifier in such a manner as to keep the noise-off level at the output of the IF amplifier constant.

The square-law detector provides an output voltage proportional to the input power. This output will consist of two voltage levels (V_1 and V_2), proportional to the two levels of noise power at the input to the IF amplifier.

$$\text{Noise-on voltage: } V_2 = pN_{o2} \tag{5-10}$$

$$\text{Noise-off voltage: } V_1 = pN_{o1} \tag{5-11}$$

The peak-to-peak amplitude of the square wave is measured by the synchronous detector and the resultant voltage is indicated by the meter.

Therefore, the meter voltage

$$V_m = c\,(V_2 - V_1) \tag{5-12}$$

From equations 5-10 and 5-11

$$V_m = p\,(N_{o2} - N_{o1}) \tag{5-13}$$

Rearranging terms

$$V_m = pN_{o1}\left(\frac{N_{o2}}{N_{o1}} - 1\right) \tag{5-14}$$

From the previous discussions

$$\frac{N_{o2}}{N_{o1}} = Y$$

Therefore,

$$V_m = pN_{o1} (Y - 1) \tag{5-15}$$

From equation 5-9

$$V_m = pN_{o1} \frac{T_{ex}}{F} \tag{5-16}$$

Equation 5-16 indicates that, if T_{ex} is known and N_{o1} is constant (a condition satisfied by the gated detector and AGC amplifier), the meter voltage is inversely proportional to the noise figure of the device under test. This is a highly desirable result since lower noise figures read closer to full scale and thus greater resolution is achieved.

Note also that because a square-law detector is used, the meter scale, when calibrated in dB, becomes logarithmic, and thus produces a natural expansion on the upper half of the scale (where low noise figures are indicated).

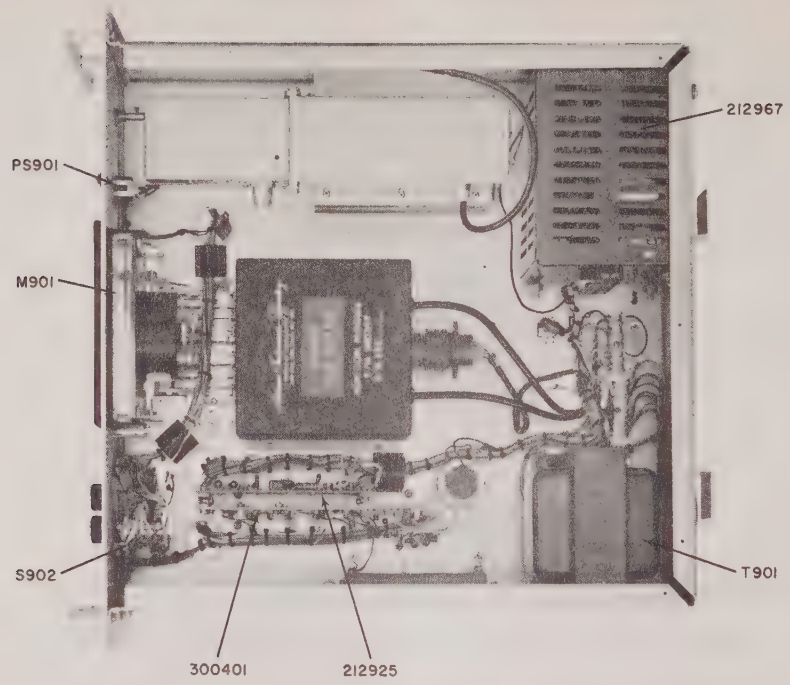


FIGURE 6-1. TYPE 75 PANFI TOP VIEW

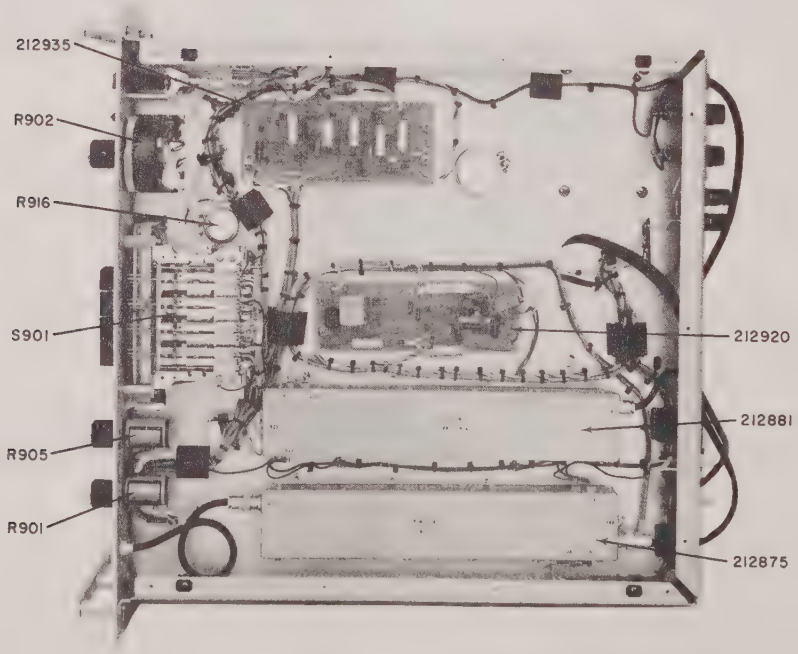


FIGURE 6-2. TYPE 75 PANFI BOTTOM VIEW

SECTION VI
MAINTENANCE

6.1 GENERAL

The use of solid-state components for all active elements, and the selection of high-quality components, assures a long trouble-free life for the type 75 Precision Automatic Noise Figure Indicator. The entire unit is guaranteed against defects in materials and workmanship, as stated in the warranty located in the front of this handbook.

Information to aid in the isolation of a trouble is provided below. Figure 6-1 shows a top view of the Type 75 PANFI; Figure 6-2 shows a bottom view.

6.2 FACTORY REPAIR

It is recommended that when a faulty subassembly is located, it be returned to the manufacturer for repairs. When this is done, please follow these instructions:

- Write to the AIL Microwave Instruments Sales Department giving complete information concerning the failure. Include the unit type and serial number.
- Special shipping instructions will be supplied by AIL. Pack and ship the equipment as directed. Transportation charges should be prepaid and a failure report should be supplied with the equipment.

6.3 ADJUSTMENTS

The Type 75 PANFI has been designed for minimum maintenance and has few internal adjustments (refer to schematic Figure 6-3). There is only one internal adjustment necessary to insure that the Type 75 is fully calibrated and operational. This adjustment correlates the automatic reading to the CAL ADJ control on the calibrate scale. This can be checked very simply at any time during the operation. The procedure is as follows:

1. Using an AIL Type 32 Precision Attenuator, carefully make a manual noise figure measurement (Section IV).
2. Switch over to the CAL mode and set the CAL ADJ control for the correct excess noise ratio.
3. Switch to AUTO and note the automatic noise figure reading. This should be done for one noise figure reading on each scale of the meter.
4. Compare the results with the manual readings. When the PANFI is out of adjustment, the automatic readings will differ from the manual readings in the same direction by approximately the same amount (that is, difference = -0.3 dB).
5. Correct the meter by adjusting the CAL ADJ control in the AUTO mode such that the automatic and manual readings agree.
6. Depress the CAL mode button and adjust R916 to return the calibrate reading on meter to that value previously set. The Type 75 PANFI is now ready for operation.

A Type 75 PANFI with a Type 76 Modulator (PANFI P/N 07511, 07512) would require periodic calibration of the Type 76 Modulator output. This is accomplished as follows.

To calibrate the modulator output, locate the Type 76 Modulator mounted on the right side-wall of the chassis just behind the front panel. A multiturn trim potentiometer is mounted on the PC board with the screw adjustment up. Monitor the modulator output with a digital or differential voltmeter at the diode gate BNC jack on the rear panel of the PANFI. With the PANFI in the MANUAL ON mode and gas-diode switch in DIODE position, set the trim pot for an output between 28.00 and 28.10 volts. Turning the screw adjustment CW increases the output; CCW decreases the output.

6.4 TROUBLESHOOTING

The remainder of this section is intended to aid in servicing this instrument. Detailed descriptions of the circuitry followed by a discussion of operation and troubleshooting, a schematic diagram, component layout, and list of quiescent voltages are given for each PC board or module where required, except for the modular power supply in 6.4.1.2.

6.4.1 POWER SUPPLIES

6.4.1.1 GENERAL

The Type 75 PANFI is powered by two solid state power supplies operating from the primary ac power through the two fuses (F_1 and F_2). If fuses F_1 and F_2 are blown, the fault can be located by disconnecting both power supplies from the primary power line. Reconnect the power supplies one at a time to determine the faulty unit.

6.4.1.2 MODULAR 20-V POWER SUPPLY (P/N 212967)

This power supply provides regulated +20 and -20 volts to all submodules in the Type 75 and an unregulated 40 volts to the Type 76 Modulator. Primary ac input power and dc output power are provided on one terminal strip. The dc voltages are adjustable by $\pm$10 percent, around

20 volts, by two controls which are located on the power supply. The terminal strip with its input (115/230 VAC) and output (+20, -20, +40, ground) designations is shown in the schematic diagram of the PANFI (Figure 6-3).

If a malfunction is traced to this module it is recommended that it be returned to the manufacturer for repair or replacement.

6.4.1.3 300-VOLT POWER SUPPLY

See paragraph 6.4.8.2 for discussion of the 300-volt power supply.

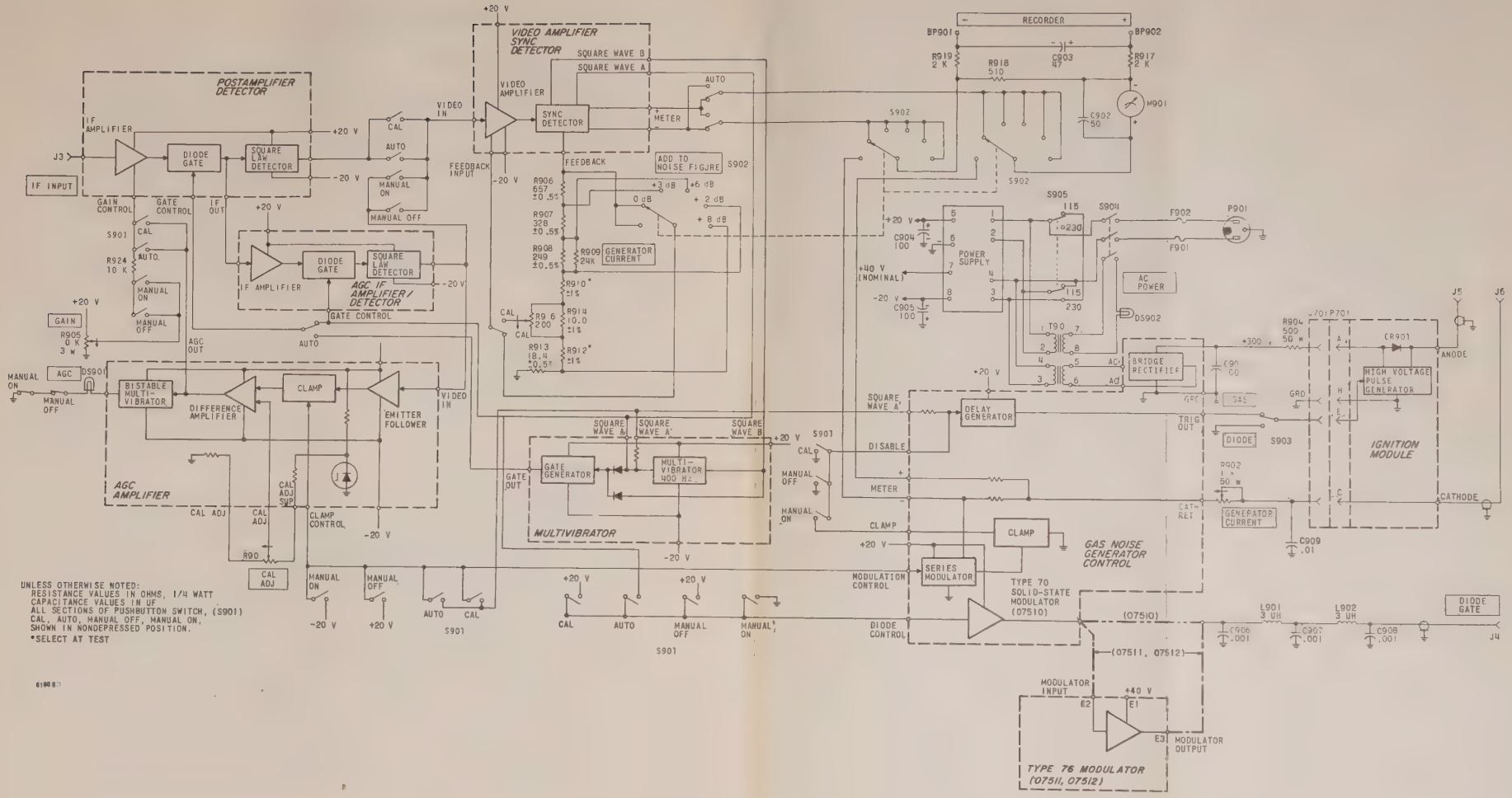


FIGURE 6-3. SCHEMATIC DIAGRAM OF PANFI

FIGURE 6-3

6.4.2 POSTAMPLIFIER DETECTOR (P/N 212875)

6.4.2.1 CIRCUIT DESCRIPTION

The function of this module is the amplification of the incoming noise signal to a level that may be detected in the square-law detector and processed by following circuits. The IF gain of this amplifier is controlled, during the automatic and calibrate mode of operation, by the noise from the system under test (when the noise generator is turned off).

The module is composed of three subsections as discussed in the following paragraphs. (Refer to schematic Figure 6-4 and component layout Figure 6-5).

30-MHz AMPLIFIER

The 30-MHz amplifier section consists of four transistor stages arranged in a common-emitter configuration. These are synchronously tuned to 30 MHz, with an overall bandwidth of 5 MHz. Interstage coupling is achieved using autotransformers which provide the proper impedance matching for the desired bandwidth and stability.

Three PIN diodes (CR101, 102, and 103) are used to provide gain control on the first three stages. As the current in these diodes is increased, their conductance increases, shunting the signal to ground and thereby reducing the stage gain. These diodes provide more than 65 dB of gain control range and are used in all modes of operation (automatic, manual, and calibrate). The first three stages are designed to have a bandwidth greater than 20 MHz to prevent changes in the overall bandwidth or center frequency as the gain is adjusted. The first two stages use heavy emitter degeneration and are operated at a relatively high current to prevent saturation when the input signal level is high and the gain is turned down near its minimum point. Input signal levels having peak value of 0 dBm can be handled by this amplifier when the gain is decreased fully. This is required by the 65-dB dynamic range of the Type 75 PANFI.

DIODE SWITCH

The second basic section of this module is the diode switch composed of two PIN diodes arranged in such a manner that, with the application of a positive voltage to C138, the shunt diode (CR104) is biased off (a high impedance) and the series diode (CR105) is biased on (a low impedance), thereby allowing the signal to pass. When a negative voltage is applied, the diodes reverse their operation and provide, typically, 40 dB of signal reduction.

During the automatic mode of operation, the switch is opened during the first 200 μs of the noise generator on-time. This prevents the PANFI from being sensitive to variations of noise generator turn-on time.

During the manual operation, this switch is alternately turned on and off at approximately a 400-Hz rate. This provides a 400-Hz modulated noise signal that can be presented on the meter by the synchronous detector, thus allowing the noise generator to be operated in a CW condition and permitting a true manual measurement.

SQUARE-LAW DETECTOR

The third and final section of this module is the square-law detector. This device consists of a differential amplifier pair (Q105 and Q107) whose current is supplied from a second amplifier (Q106). One side of the differential amplifier is grounded; the other side is driven from the same signal source as Q106. The result is that the output current flowing in R135 and R136 is the square of the input voltage (or current). This signal is then coupled to the output through an emitter follower which prevents the video amplifier from loading the detector.

6.4.2.2 TROUBLESHOOTING

See paragraph 6.4.3.2.

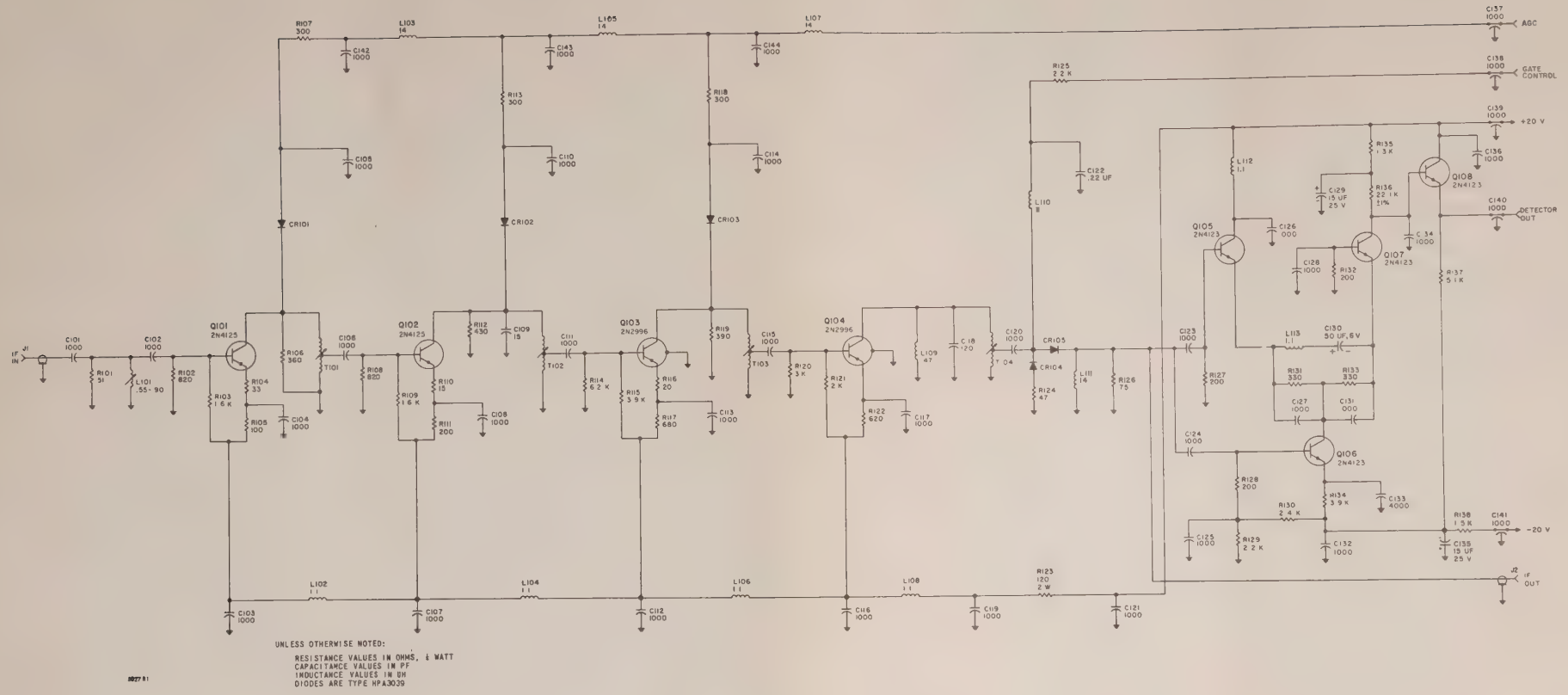


FIGURE 6-4. SCHEMATIC DIAGRAM OF POSTAMPLIFIER DETECTOR

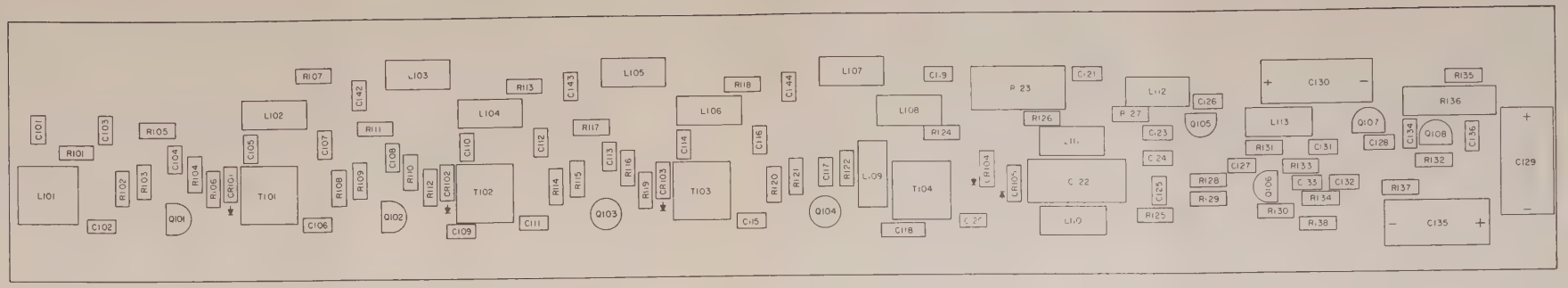


FIGURE 6-5. COMPONENT LAYOUT OF POSTAMPLIFIER DETECTOR

TABLE 6-1. POSTAMPLIFIER-DETECTOR VOLTAGES (P/N 212875)

Test Point	Auto Mode No Input to Type 75 Voltage (in volts)	Test Point	Auto Mode No Input to Type 75 Voltage (in volts)
Q101E	4.2	Q105B	0.0
Q101B	3.5	Q105E	- 0.62
Q102E	4.1	Q106B	- 5.0
Q102B	3.4	Q106E	- 5.6
Q103E	6.4	Q106C	- 0.9
Q103B	6.0	Q107C	6.4
Q104E	6.0	Q107B	0.0
Q104B	5.8	Q107E	- 0.66
C139	20.0	Q108C	20.0
Junction L108 and R123	9.4	Q108E	6.0
		Junction R138 and C135	-10.4

NOTE: All voltages listed in the tables are ±20 percent, measured with a 20,000 ohm/volt dc meter (referenced to ground).

6.4.3 AGC IF AMPLIFIER AND DETECTOR (P/N 212881)

6.4.3.1 CIRCUIT DESCRIPTION

During the automatic and calibrate modes, this module produces an output proportional to the level of the noise-off signal. This output is amplified by the AGC amplifier and used to hold the gain of the IF amplifier constant. During the manual mode, it provides additional IF gain. It is composed of three basic units as discussed in the following paragraphs. (Refer to schematic Figure 6-6 and component layout Figure 6-7.)

30-MHz AMPLIFIER

This amplifier is an RC-coupled, three-stage, feedback amplifier designed for broadband stable operation. The bandwidth and gain are determined by the feedback circuit composed of R210, R207, and C204; this results in a bandwidth greater than 60 MHz and a gain of 20 dB. A feedback amplifier is used because of its inherent gain stability. If the gain were to vary, the AGC voltage controlling the IF amplifier-detector would change, causing an error in the noise figure indicated on the meter. The dc operating points of the three stages are stabilized by using dc feedback.

DIODE SWITCH

The diode switch that follows the 30-MHz amplifier is identical to the switch discussed in paragraph 6.4.2.1. In the automatic and calibrate modes, this switch alternates between a high and low loss, at a 400-Hz rate. It is driven in such a manner that it is in the low-loss position during the noise-off time, thereby allowing the following circuits to respond only to the noise-off signal, while ignoring the noise-on signal.

SQUARE-LAW DETECTOR

The square-law detector operates in identically the same way as that discussed in paragraph 6.4.2.1. Its output is a 400-Hz signal proportional to the noise-off signal.

During the automatic or calibrate operation, this signal is processed by the AGC amplifier to provide a dc output proportional to the noise-off signal. When the manual mode is used, the output of the square-law detector is connected to the input of the video amplifier-synchronous detector and used to drive the meter.

6.4.3.2 TROUBLESHOOTING

IF AMPLIFIER CIRCUITS

Two IF amplifier circuits are used--a tuned amplifier in the postamplifier-detector module and a feedback amplifier in the AGC IF-amplifier module.

During the manual modes of operation, the two amplifiers are cascaded, and the signal flows through both amplifiers before being processed for display on the meter.

During the automatic and the calibrate modes, the signal which is displayed on the meter flows only through the tuned IF-postamplifier before being processed for display. In the meantime, the feedback IF amplifier, in the AGC IF amplifier-detector module, takes the output signal from the postamplifier, amplifies it, and applies it to the processing circuits which ultimately generate a dc signal for the gain control circuits in the postamplifier.

Failure of either amplifier will cause a failure in all modes of operation. To determine which amplifier has failed, switch to the manual mode and insert a 30-MHz CW signal into the IF input. Examine the outputs of each of the square-law detectors.

CAUTION

The output of the detector in the AGC IF amplifier-detector module is dc-coupled and a short-to-ground at this point will damage this unit.

If no output appears from either detector, the postamplifier should be checked (using Table 6-1). If an output appears from the postamplifier-detector output, but none from the AGC IF amplifier-detector output, the feedback amplifier should be checked (using Table 6-2).

DIODE SWITCHES

Two diode switches are used in the Type 75 PANFI--one between the postamplifier and its square-law detector (for this discussion this will be called switch A); the other (switch B) between the feedback amplifier and its square-law detector in the AGC IF amplifier module.

Switch B is operated by a 400-Hz square wave, derived from the astable multivibrator, during all modes of operation. Switch A is driven by the same signal during the calibrate and manual modes. During the automatic mode, switch A is operated by a 200-μs pulse, derived from the monostable multivibrator.

Failure of switch A will show up as a lack of meter deflection in the CAL mode. Failure of switch B will prevent the AGC light from going on in either the automatic or CAL mode.

SQUARE-LAW DETECTORS

Two square-law detectors are used in the Type 75 PANFI--one in the postamplifier-detector module (detector A), and one in the AGC IF amplifier-detector module (detector B).

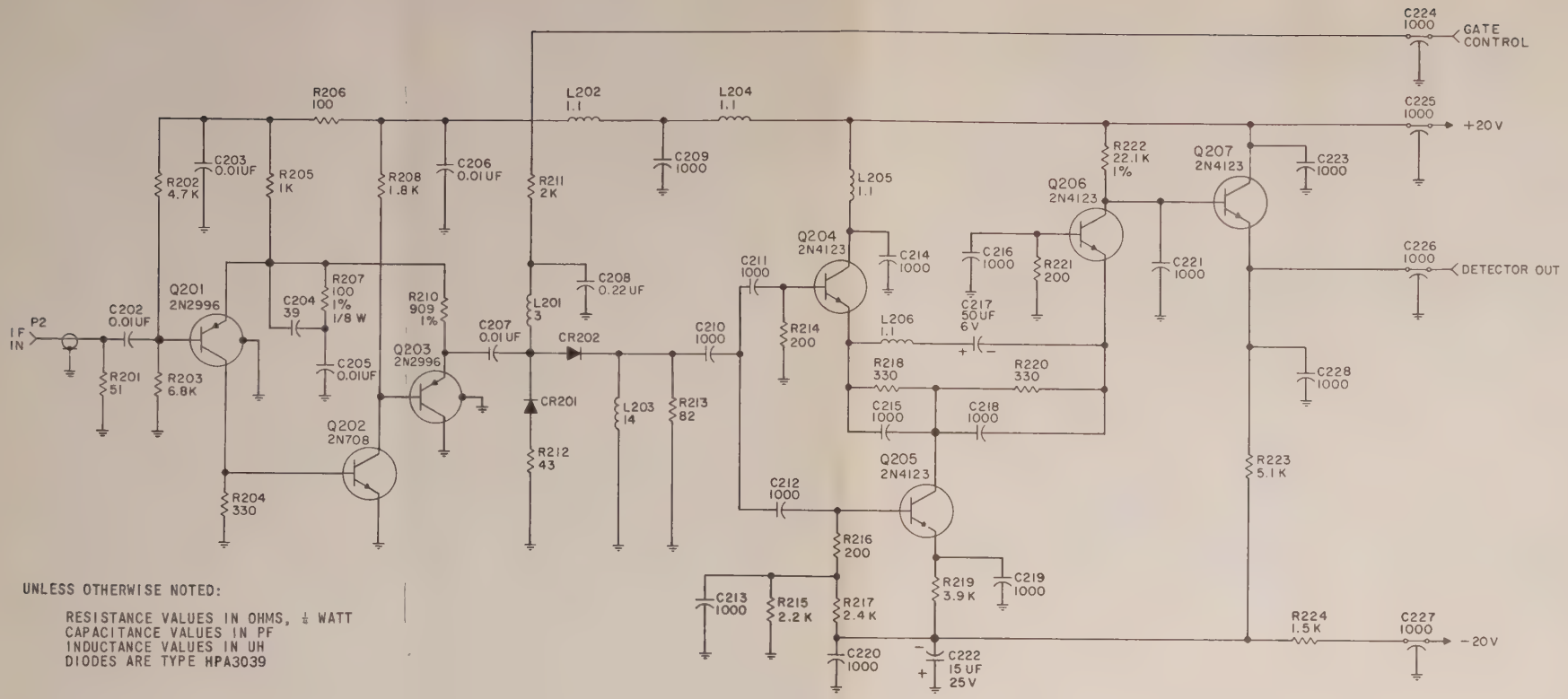
The output from detector A is not used in the manual modes of operation. It is fed to the video amplifier in the automatic and calibrate modes. The output from detector B is fed to the video amplifier in the manual mode. In the automatic and calibrate modes its output is fed to the AGC amplifier. At all times it is dc-coupled to the AGC amplifier.

CAUTION

Do not short this output, as this will result in damage to the square-law detector.

Failure of detector A will be indicated by no front panel meter reading in the automatic or calibrate modes. Its failure will have no effect on the manual mode.

Failure of detector B will show up as an inability to obtain a meter reading in the manual mode of operation and will prevent the AGC indicator from lighting in the automatic or calibrate mode. The dc voltages for these detectors are given in Tables 6-1 and 6-2.



UNLESS OTHERWISE NOTED:

RESISTANCE VALUES IN OHMS, ¼ WATT
CAPACITANCE VALUES IN PF
INDUCTANCE VALUES IN UH
DIODES ARE TYPE HPA3039

FIGURE 6-6. SCHEMATIC DIAGRAM OF AGC IF AMPLIFIER/ DETECTOR

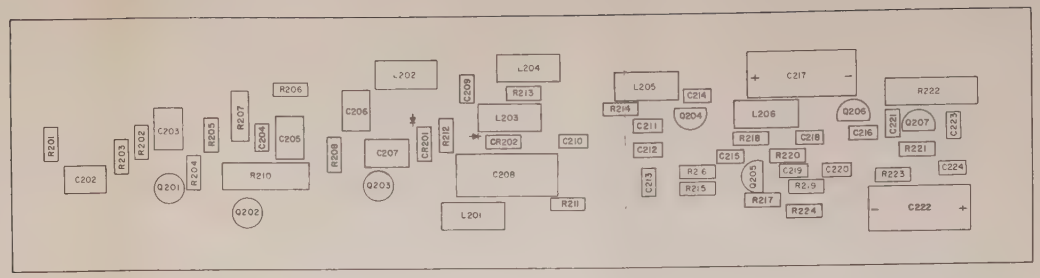


FIGURE 6-7. COMPONENT LAYOUT OF AGC IF AMPLIFIER/DETECTOR

TABLE 6-2. AGC IF AMPLIFIER (P/N 212881)

Test Point	Auto Mode No Input to Type 75 Voltage (in volts)	Test Point	Auto Mode No Input to Type 75 Voltage (in volts)
Q201B	11.2	Q204C	20.0
Q201C	0.67	Q204E	- 0.68
Q201E	11.7	Q205C	- 0.86
Junction R206 and R205	19.0	Q205B	- 5.0
		Q205E	- 5.6
Q202E	0	Junction R223 and R224	-10.6
Q202C	6.3		
Q203E	6.8	Q206E	- 0.65
C225	20.0	Q206B	0
Q204B	0	Q206C	5.4
		Q207C	20.0
		Q207E	5.0

NOTE: All voltages listed in the tables are ±20 percent, measured with a 20,000 ohm/volt dc meter (referenced to ground).

6.4.4 AGC AMPLIFIER (P/N 212935)

6.4.4.1 CIRCUIT DESCRIPTION

This unit accepts the 400-Hz output from the square-law detector, described in paragraph 6.4.3.1, and produces a dc output, capable of controlling the gain of the postamplifier described in paragraph 6.4.2.1. (Refer to schematic Figure 6-8 and component layout Figure 6-9.)

During the automatic and calibration modes, the 400-Hz detector output is connected to the base of Q509 (E507), an emitter-follower used to prevent loading of the square-law detector. The output of Q509 is applied to an integration network (R518 and C506), which converts the 400-Hz signal to a dc voltage. Q508 is a p-channel FET which clamps the signal entering R518 to ground during the noise-on time. This restores the dc level to the signal, lost by ac coupling in previous circuits. The integrated dc signal is applied to one side (Q507) of a differential amplifier pair (Q507 and Q506). This differential amplifier compares this input voltage to a level preset by R511, R901, and a stable zener diode (CR503). When this input level is greater than that set by R901, the difference in the collector voltages of Q506 and Q507 is amplified by Q503, Q504, and Q505, producing a positive voltage at E502. This is applied to the gain control diodes in the IF amplifier-detector module. This output voltage will vary between approximately 0 volt (no gain control) and +2 volts (65-dB gain reduction).

When the input level to the AGC amplifier exceeds the preset level, thereby producing a positive output voltage, Q502 is turned on, which in turn causes Q501 to conduct. When Q501 conducts, DS901 (the AGC light on the front panel) illuminates, indicating that the input level to the Type 75 PANFI is high enough for the AGC circuits to control the operation and thus hold the noise-off signal constant. When Q501 conducts, Q502 and the entire indicator circuit is locked-up by regenerative action, until the input signal is

removed. R901 is used to change the preset voltage during the calibration mode. This varies pN_{01} of equation 5-16 and creates the same effect as if T_{ex} were varied.

6.4.4.2 TROUBLESHOOTING

This module amplifies the output of square-law detector B and generates a proportional dc voltage. It also lights the AGC indicator when the input level is above a preset reference level. Failure of this mode will result in a large error in the automatic noise figure, or the calibrate level, as displayed on the front panel meter in the automatic or calibrate modes, respectively. It will also show up as a failure to light the AGC light on the front panel. Table 6-3 lists the dc voltages for this module.

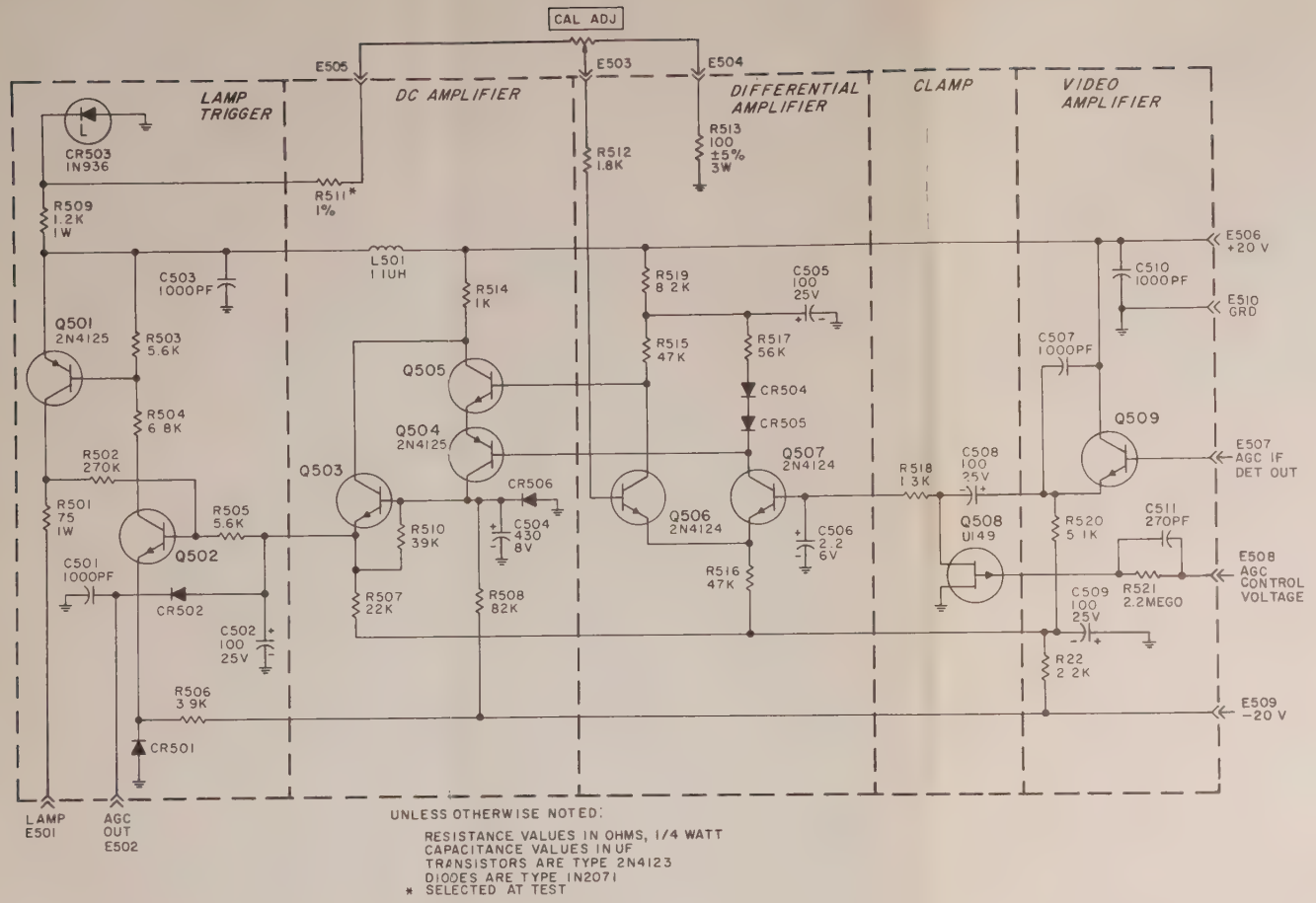


FIGURE 6-8. SCHEMATIC DIAGRAM OF AGC AMPLIFIER

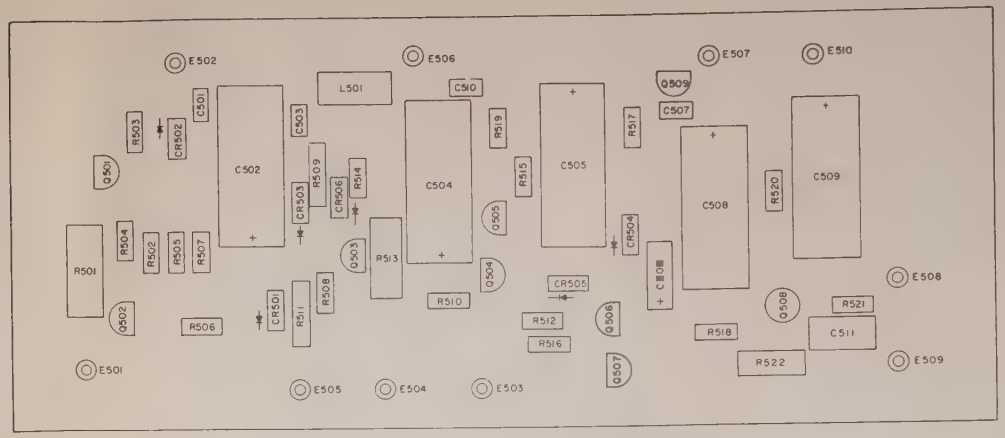


FIGURE 6-9. COMPONENT LAYOUT OF AGC AMPLIFIER

TABLE 6-3. AGC AMPLIFIER (P/N 212935)

Test Point	Voltage (in volts) No Input to Type 75; CAL Button Depressed; AGC Light OFF	Voltage (in volts) -60 dBm Input to Type 75; AUTO Button Depressed; AGC Light ON
Video in (Q509B)	5.0	5.0
Q509C	20.0	20.0
Q509E	4.2	4.2
Junction R522 and R516	-11.8	-11.6
Junction R518 and C508	0	0.52
Q507B	0	0.52
Q507C	17.2	15.0
Q507E	- 0.10	0.02
Junction R517 and R515	18.0	18.0
Q506C	6.8	8.4
Q506B	0.5	0.62
CAL ADJ (R901)	min - 0.10 max - 0.62	min - 0.10 max - 0.62
CAL ADJ RET	0.10	0.10

Test Point	Voltage (in volts) NO Input to Type 75; CAL Button Depressed; AGC Light OFF	Voltage (in volts) -60 dBm Input to Type 75; AUTO Button Depressed; AGC Light ON
CAL ADJ SUP	0.62	0.62
Junction R511 and R509	9.0	9.0
Junction R509 and L501	20.0	20.0
Q505C	19.4	19.0
Q505E	11.6	11.0
Q504C	- 0.46	1.6
Q503E	- 1.06	1.0
Q502B	- 1.04	0.13
Q502E	- 0.62	- 0.58
Q502C	20.0	- 0.50
Q501B	20.0	19.0
Q501E	20.0	20.0
Q501C	0	20.0

6.4.5 VIDEO AMPLIFIER-SYNCHRONOUS DETECTOR (P/N 212920)

6.4.5.1 CIRCUIT DESCRIPTION

This module amplifies the 400-Hz output of the square-law detector and produces a current in the dc meter which is proportional to the difference in the two levels. The unit is composed of two sections, an amplifier and a detector, with a feedback loop around the two. (Refer to schematic Figure 6-10 and component layout Figure 6-11.)

The video amplifier utilizes both ac and dc feedback for highly stable operation. There are essentially three feedback paths. The first is a dc feedback path through R315 to the base of Q301 which stabilizes the dc operating points of the transistors. The second is an ac path from the center tap of T301 through a variable resistor in the emitter of Q304. This eliminates zero offset on the meter due to transformer or diode imbalances, and provides a means of changing meter scales by increasing the gain of the amplifier (decreasing the feedback). The third feedback path is both an ac and a dc path through Q303, R308, and R306. This provides both ac and dc stability in order to reduce errors during the measurement.

A 40 volt peak-to-peak reference signal is applied to E308 and E309 (primary of transformer T301) in synchronism with the 400-Hz signal appearing at the input to the video amplifier (E302). Assume that the polarity of this signal is such that the secondary of the transformer has a positive polarity on pin 5 with respect to pin 3. This signal biases CR301 and CR303 on, and CR302 and CR304 off.

The signal appearing at the input of the video amplifier is amplified and applied to the detector section through Q306 and Q307. These two transistors form an emitter follower with a large negative and positive output capability. Assume that the signal to be measured is positive at the output of C310. The current which flows will split, with approximately half flowing through R318 and half through R319. Since CR302 and CR304 are turned off, the current flowing through R319 must return through the meter and rejoin the current which is flowing out of R318. This current again splits and flows through CR301 and CR303 (the ON diodes) and into opposite ends of the transformer secondary (T301). The two currents then add again at the center tap and flow to ground through the feedback resistors chosen by S902A. It is this feedback path from the transformer of T301 back to the emitter of Q304 which linearizes the current flowing in the meter by eliminating any zero offset currents.

When the input signal is negative at E302, the 40-volt signal applied to T301 is also reversed, causing CR301 and CR303 to turn off, and CR302 and CR304 to turn on. The signal currents will then flow in the opposite direction to that previously described. The result of turning the opposite diodes on is to cause half of this negative current to flow through the meter in the same direction as the positive signal current.

Resistors R320, R321, R322, and R323 are used to develop sufficient voltage to keep the off diodes turned off for any expected level of input signal.

6.4.5.2 TROUBLESHOOTING

The video amplifier-synchronous detector module is used to amplify the two different noise levels appearing at its input, and to display the difference on the front panel meter. The front panel switch (SCALE SELECTOR) is used to change the gain of the video amplifier and, therefore, change meter scales. Failure of this switch will result in the inability to change the meter reading (in the automatic or manual modes). In the calibrate mode, this switch is disabled. Failure of either the video amplifier or the synchronous detector will result in no meter detection in any mode of operation. This can be isolated by noting that there is an output from both square-law detectors in all modes of operation. The dc operating voltages are given in Table 6-4. (Note that the voltages of several transistor bases or emitters are not given.) This is due to the fact that a meter placed in these circuits may cause the stage to oscillate. This is indicated by observing the meter reading, which will change when the stage oscillates.

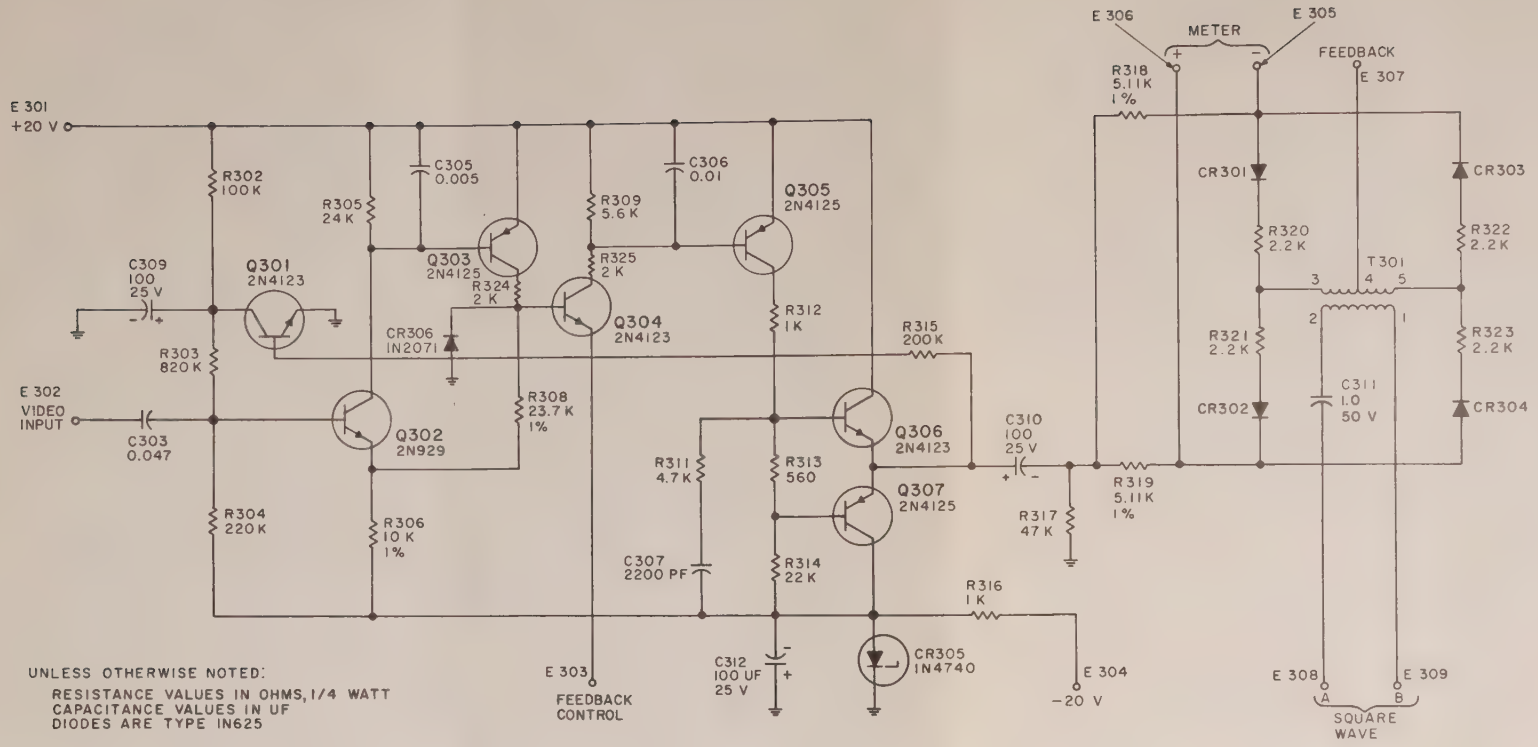


FIGURE 6-10. SCHEMATIC DIAGRAM OF VIDEO AMPLIFIER SYNC DETECTOR

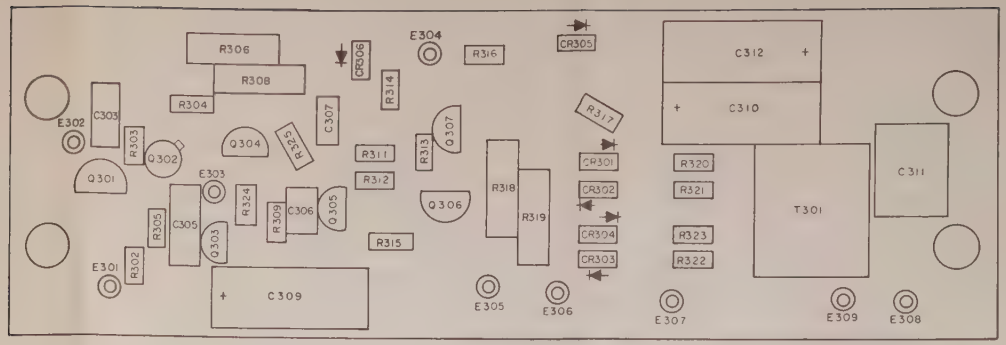


FIGURE 6-11. COMPONENT LAYOUT OF VIDEO AMPLIFIER SYNC DETECTOR

TABLE 6-4. VIDEO AMPLIFIER-SYNCHRONOUS DETECTOR (P/N 212920)

	Voltage (in volts) (Scale Selector Set to 0 dB)		
	MAN OFF Position		CAL Position
Test Point	-60 dBm In See Note	No Input	-60 dBm In See Note
Q301C	9.2	9.2	9.2
Q301E	0	0	0
Q301B	- 0.42	0.6	- 0.35
Q302E	- 6.2	- 6.2	- 6.2
Q302B	- 5.6	- 5.6	- 5.6
Q303E	20.0	20.0	20.0
Q303B	19.2	19.2	19.2
Q303C	1.3	1.3	1.3
Q304C	19.0	19.0	19.0
Q304E	0.12	0.14	0
Q305E	20.0	20.0	20.0
Q305C	0.22	0.15	0.36
Q306B	- 0.18	1.0	- 0.05
Q307B	- 0.38	- 0.75	- 0.28
Q307E	- 0.19	0.95	- 0.08
Q307C	- 9.4	- 9.4	- 9.40
E304	-20.0	-20.0	-20.0

NOTE: These readings are taken with meter reading at full scale.

6.4.6 MULTIVIBRATOR (P/N 212925)

6.4.6.1 CIRCUIT DESCRIPTION

The multivibrator module is the basic timing generator of the Type 75 PANFI. It is made up of two basic subassemblies. (Refer to schematic Figure 6-12 and component layout Figure 6-13.)

ASTABLE MULTIVIBRATOR

This subunit consists of transistors Q603, Q604, Q605, Q606, and Q607. It provides a 400-Hz square-wave output. The output (from E602) is used to drive the diode gates in both the IF amplifier and the AGC IF amplifier-detector. The transformer (T301) in the synchronous detector is connected across both E602 and E606, which provides the necessary 40-volt square wave. A third low impedance output (from the emitter follower Q603) drives the FET clamp (Q608) in the AGC amplifier and the modulation circuits in the gas-discharge noise generator control and ignition module. Each output is a square wave of approximately 18 volts peak-to-peak, and a 400-Hz frequency, which is determined by R612, R615, R616, R618, C607, and C608. The exact frequency is not critical and slight changes will not affect the operation of the PANFI.

MONOSTABLE MULTIVIBRATOR

This unit is composed of transistors Q601 and Q602, and is triggered through gating diodes CR601 and CR602. During the automatic mode of operation, its output opens the diode switch during the first 200 μs of noise-on time (as described in paragraph 6.4.2.1).

The output signals appearing at the astable multivibrator outputs (E606 and E602) are differentiated by C609 and R621, and C603 and R609, respectively, thus producing positive and negative impulses at the leading and trailing edges of the 400-Hz square wave. The positive impulses,

coupled through the gating diodes, trigger the monostable multivibrator. The output is a -20 volt pulse of 200 μs duration which causes the diode switch to open (high-loss condition). When the monostable multivibrator is in its rest state, the output is a constant 5 volts, thereby keeping the switch in its low-loss condition.

6.4.6.2 TROUBLESHOOTING

The multivibrator acts as the basic timing generator in the Type 75 PANFI. Failure of the astable multivibrator causes a failure of the Type 75 PANFI in all modes of operation. In addition, the noise generator will not operate. Failure of the monostable multivibrator will show up as an error in the automatic noise figure reading, when compared to the manual noise figure. This is due to the fact that diode switch A does not eliminate the first 200 μs of the noise pulse and the Type 75 then becomes sensitive to the various turn-on times of the noise generators. The dc operating voltages for this module are given in Table 6-5.

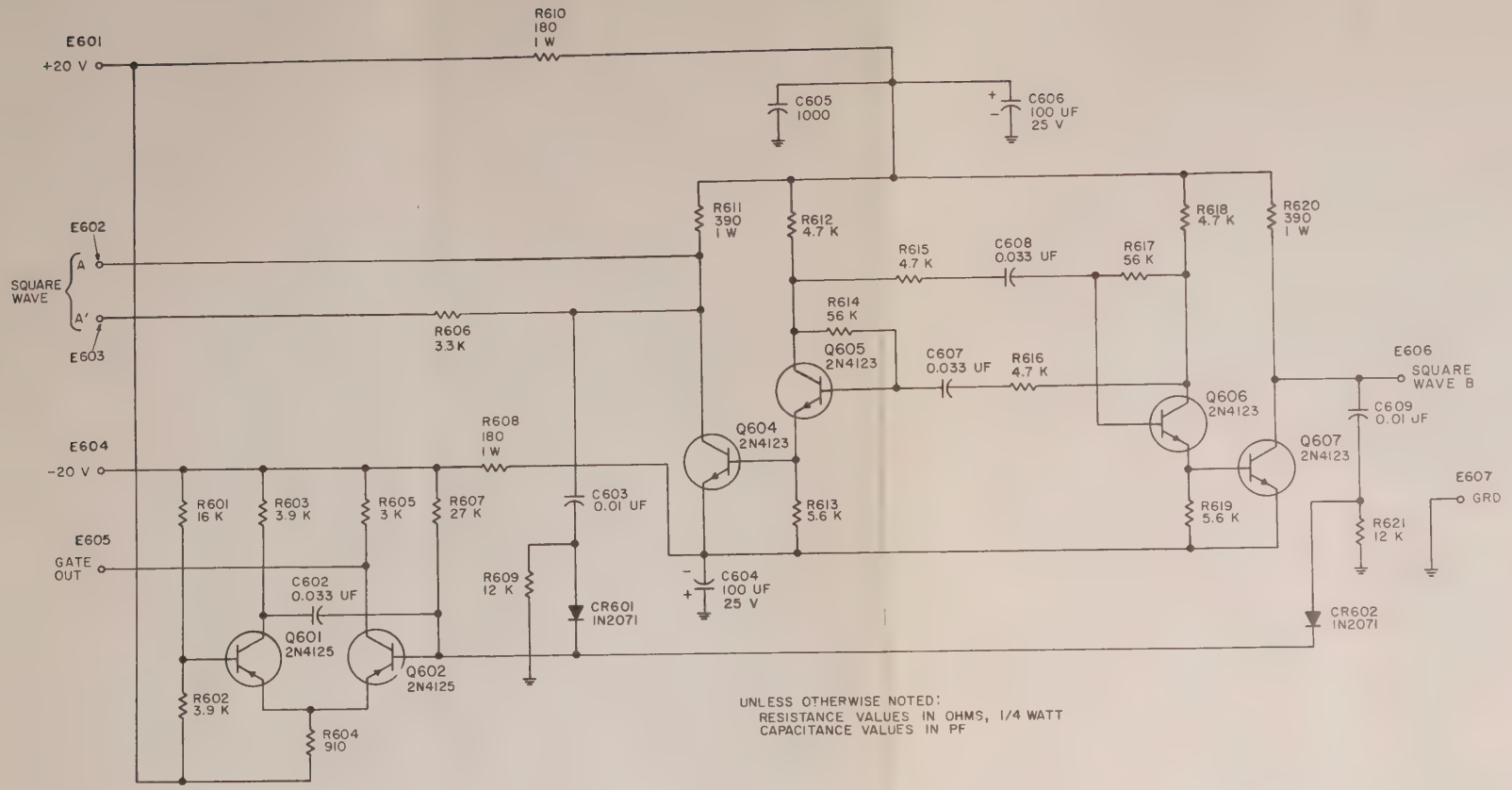


FIGURE 6-12. SCHEMATIC DIAGRAM OF MULTIVIBRATOR

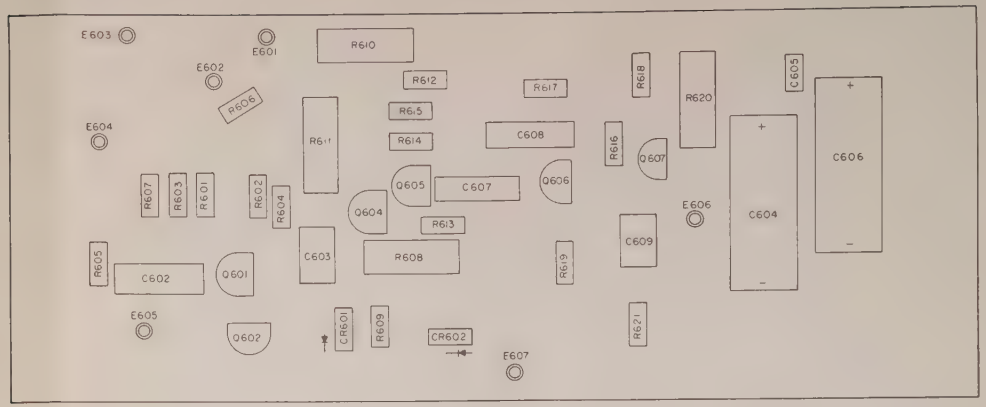


FIGURE 6-13. COMPONENT LAYOUT OF MULTIVIBRATOR

TABLE 6-5. MULTIVIBRATOR (P/N 212925)

Test Point	Voltage (in volts)		
	Emitter	Base	Collector
Q601	10.0	12.0	-12.0
602	10.0	10.2	3.0
604	- 9.0	- 9.0	- 1.3
605	- 9.0	-10.6	- 1.2
606	- 9.0	-11.0	- 0.64
607	- 9.0	- 9.0	0.54

6.4.7 GAS-DISCHARGE NOISE GENERATOR CONTROL (P/N 300401)

6.4.7.1 CIRCUIT DESCRIPTION

The gas-discharge noise generator control is used, in conjunction with the ignition module (paragraph 6.4.8) and several chassis-mounted components, to ignite, sustain, or modulate a gas-discharge or solid state noise generator during the automatic or manual modes of operation. This module is composed of four basic subunits. (Refer to schematic Figure 6-14 and component layout Figure 6-15.)

300-VOLT POWER SUPPLY

The primary ac input voltage is transformed to approximately 220 volts ac by transformer T901 located on the main chassis. This ac voltage is then full-wave rectified by diodes CR801 through CR804, and filtered by capacitor C901 on the main chassis. The resulting 300-volts dc is applied to the gas-discharge noise generator anode connector through R902, R904, and CR703. R902 is used to set the desired noise generator current during operation. R902 and R904 are current limiting resistors.

GAS MODULATOR CONTROL

The modulator control consists of transistors Q801, Q802, and Q803. When the noise generator is pulsed on, transistor Q801 receives a synchronous negative pulse. When Q801 turns off, Q802 and Q803 are provided with a positive voltage at their bases, thereby causing these transistors to switch on, completing the noise generator cathode circuit. To turn the noise generator off, a positive pulse is applied to Q801, causing this stage to saturate, grounding the bases of Q802 and Q803. This turns these transistors off, which in turn causes the noise generator to extinguish. During the automatic mode, this operation continues at a 400-Hz rate. During manual operation, once the noise generator is turned on, no further pulsing action is required. Therefore, when the noise generator is on, its current returns to ground through R808 which develops a voltage sufficient to saturate Q804.

Saturation of Q804 reduces its collector voltage to approximately zero volt and disables the delay generator discussed in the next paragraph. Resistor R807 samples the noise generator current, and, in conjunction with R806, provides an indication of the current on the meter when the scale selector is in NOISE GENERATOR position.

DELAY GENERATOR

In order to avoid problems associated with the starting of the gas-discharge noise generator, the firing pulse is delayed approximately 75 μs to permit the diode gate in the IF postamplifier to become fully effective. This delay is accomplished by transistors Q807 and Q804. When Q807 is cut off during the negative portion of the square wave applied to its base, a positive-going ramp is generated in its collector circuit. When this ramp reaches the firing voltage of the unijunction transistor, Q805, a positive trigger voltage is produced across R815. This pulse is used to trigger the high voltage pulse generator (paragraph 6.4.8).

TYPE 70 SOLID STATE MODULATOR (07510)

The Type 70 Solid State Modulator consists of a single transistor, Q806, which is used to control the current supplied to an external solid state RF noise source (AIL part number 07001). In the CAL or MANUAL OFF positions 20 volts is applied to the base of the transistor through R817 which saturates this transistor and stops the flow of current to the noise diode. In the MANUAL ON position the base is grounded through R817, the transistor is cut off, and the flow of current to the noise diode is controlled by R818. In the AUTO position a square wave alternately turns the noise diode on and off.

6.4.7.2 TROUBLESHOOTING

See paragraph 6.4.8.2.

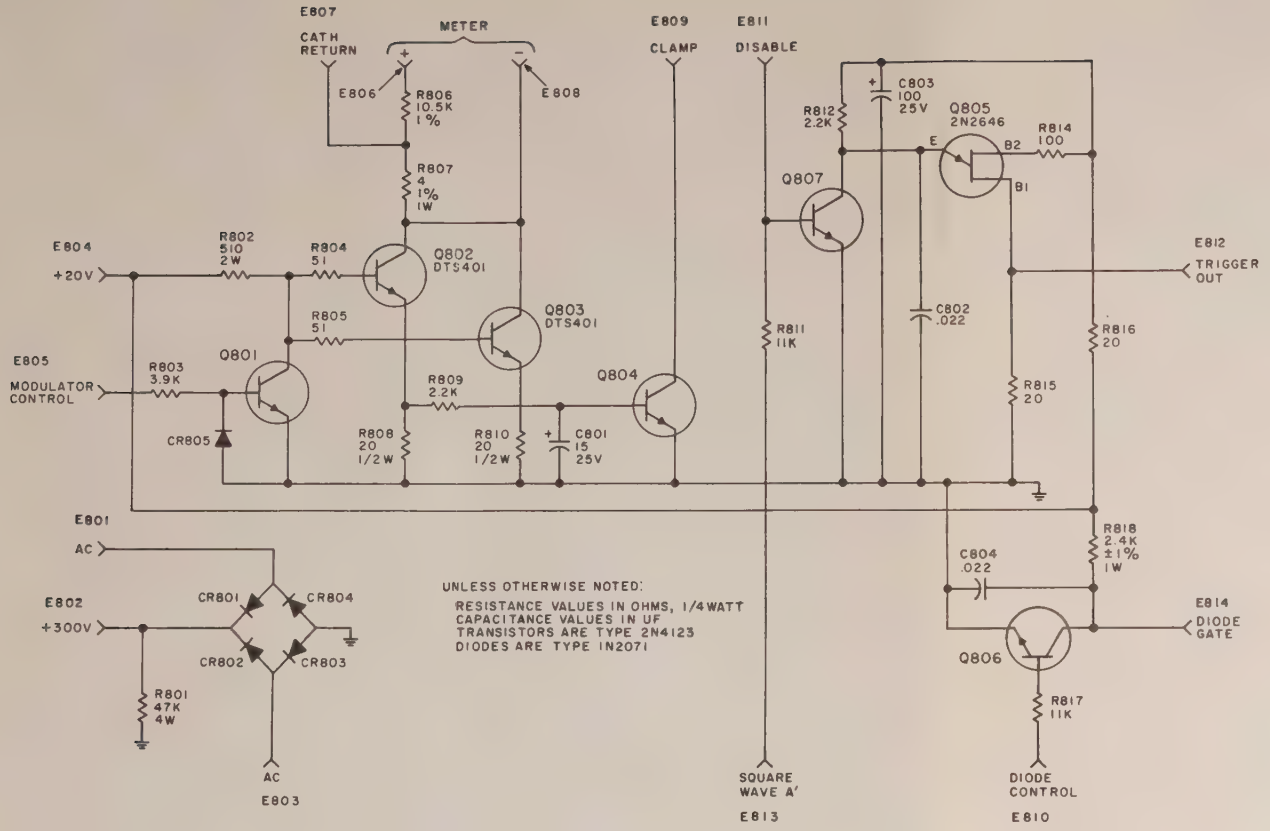


FIGURE 6-14. SCHEMATIC DIAGRAM OF GAS-DISCHARGE NOISE GENERATOR CONTROL

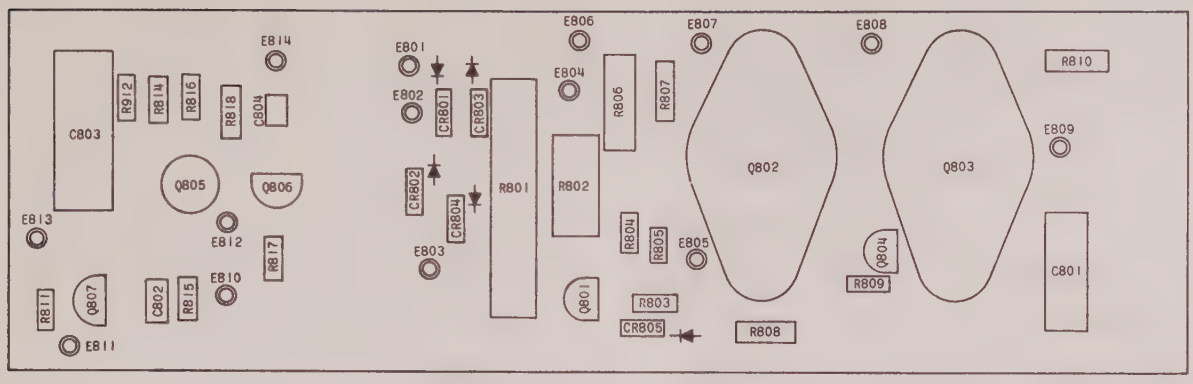


FIGURE 6-15. COMPONENT LAYOUT OF GAS-DISCHARGE NOISE GENERATOR CONTROL (P/N 300401)

TABLE 6-6. GAS-DISCHARGE NOISE GENERATOR CONTROL (P/N 300401)

Test Point	Voltage (MAN-ON) (in volts) (Note 1)	Voltage (MAN-OFF) (in volts) (Note 2)	Voltage (AUTO) (in volts) (Note 3)
AC to AC	240 ac	250 ac	240 ac
+300	320.0	340.0	325.0
R904 White lead	230.0	340.0	275.0
MOD CONTROL	-20	+20	(Note 4)
Q801B	-0.60	0.75	0.10
Q801C	3.60	0.01	1.8
Q803E, Q802E	2.20	0	1.0
Meter (-) (E808)	2.20	0.10	132.0
Meter (+) (E806)	2.35	0.10	132.0
Q804B	0.70	0	0.62
Q804C	0	0.15	0
Q805E	1.5	1.5	1.0
Q805B1	0.40	0.30	0.16
Q805B2	19.0	18.5	19.0
Q806B	0	0.74	-3.3
Q806C	20.0	0	9.6
Q807B	0	0	2.35
Q807C	1.5	1.5	1.0

Notes: 1. Gas-discharge noise generator connected (07012), operating at 175 mA.

2. Gas-discharge noise generator connected (07012), no current.

3. Gas-discharge noise generator connected (07012), current set at 175 mA in MANUAL ON mode.

4. 9-volt p-p square wave.

6.4.8 IGNITION MODULE (P/N 300397) 07510, 07511

6.4.8.1 CIRCUIT DESCRIPTION

The ignition module is used in conjunction with the gas-discharge noise generator control. The ignition module is removable from the main chassis to permit remote operation of a gas-discharge noise generator at a remote location up to 1000 feet away. The schematic of this unit is shown in Figure 6-16 and the component layout in Figure 6-17. The 300-volt supply is used to charge C701 to the full supply voltage. When a trigger pulse is received the SCR conducts and causes C701 to discharge through the primary of T701. This heavy current surge causes a high-voltage pulse to be generated in the secondary winding which is coupled to the anode cable for the gas-discharge noise generator through diode CR702. CR701 is used to isolate the 300-volt supply from the high-voltage pulse.

6.4.8.2 TROUBLESHOOTING

GAS-DISCHARGE NOISE GENERATOR CONTROL AND IGNITION MODULE

These two subunits are grouped together, because one will not work without the other. The ignition module generates the pulse necessary to ignite the gas-discharge noise generator (typically 5 kV) when the GAS-DIODE switch is in the GAS position. The gas-discharge noise generator control sustains the noise generator, and contains the modulator circuits used during the automatic mode of operation. Failure of the ignition module will be indicated by the absence of the ignition pulse. This pulse may be viewed, using a high-voltage probe and an oscilloscope, at the junction of CR701 and CR702.

Failure of the gas-discharge noise generator control will prevent the gas noise generator from being sustained (failure in the 300-V supply) or

will result in the inability to either modulate or turn off the noise generator without disconnecting the anode or cathode lead (failure of Q801, Q802, Q803, or Q804). Table 6-6 gives the dc voltages for this module.

+300-VOLT DC POWER SUPPLY

This power supply provides the sustaining voltage for the gas-discharge noise generators. Since this is an unregulated power supply, the output voltage will be a function of the load. To check this power supply, perform the procedures listed in the following steps.

1. Press the MANUAL OFF button and check for approximately +350 V dc at E802.
2. If no voltage (or low voltage) is present, check the ac voltage between E801 and E803. This should be about 250 V ac.
3. With a gas-discharge noise generator connected and drawing about 200 mA in the MANUAL ON mode, the voltage at E802 should drop to about 295 V dc. If the voltage is very low when the MANUAL ON button is depressed, check the current on the front panel meter. If it is unstable, or very low, replace the noise generator.
4. If the voltage is low regardless of which mode button is depressed, check the condition of the four bridge-rectifier diodes (CR101 through CR104) for an open circuit.

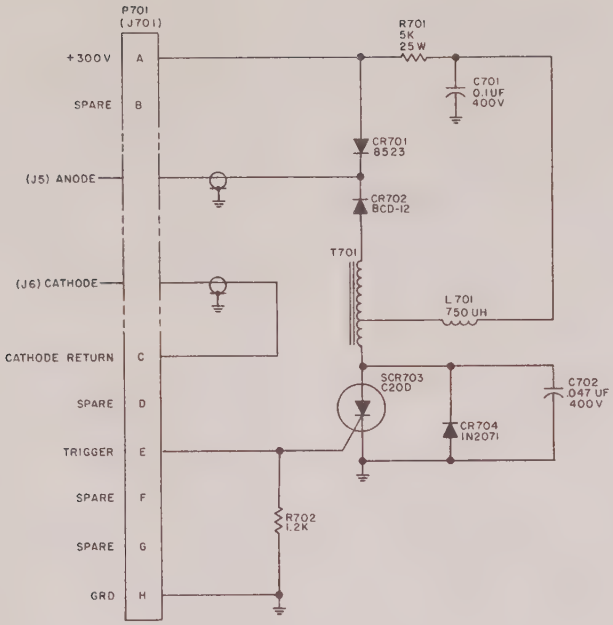


FIGURE 6-16. SCHEMATIC DIAGRAM OF IGNITION MODULE

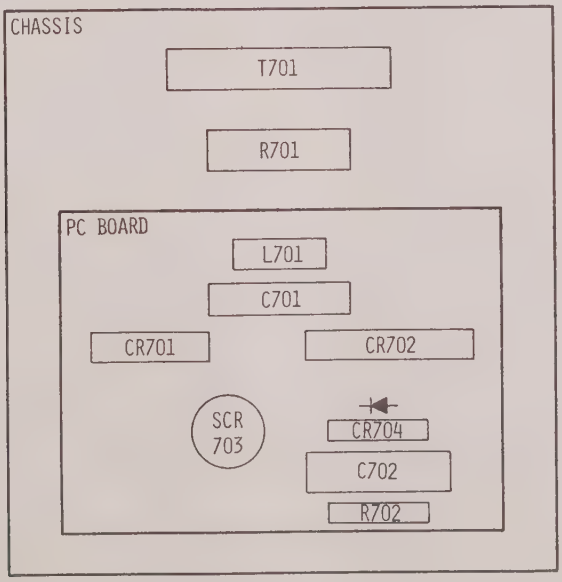


FIGURE 6-17. COMPONENT LAYOUT OF IGNITION MODULE

6.4.9 TYPE 76 MODULATOR (P/N 301331) 07511, 07512

The Type 76 Modulator is a very accurate series regulator. An unregulated rectified supply is regulated down to approximately 28 volts; this output is then sampled and compared to a very stable reference voltage in a differential mode. The difference, or error, voltage between the desired output (28 volts) and the actual output changes the actual output in a direction to minimize the difference. The accuracy of the output voltage depends on the stability of the reference voltage and the gain of the differential amplifier feedback loop (Figure 6-18).

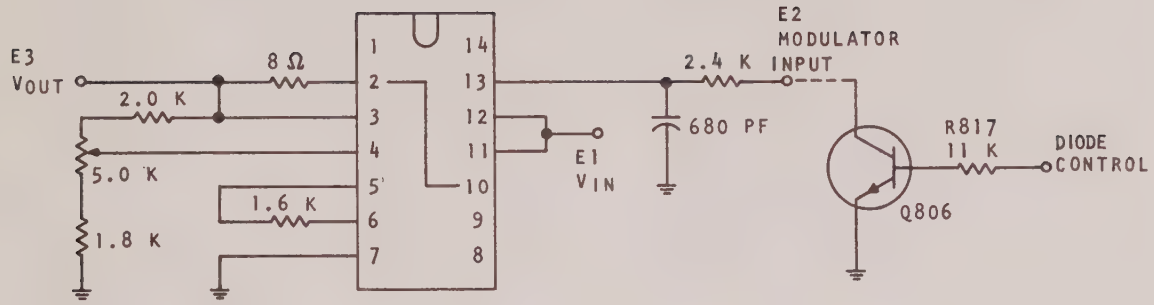
The regulator circuit uses a Fairchild μA723C integrated circuit which provides a very stable reference voltage, a high-gain comparator (differential amplifier), and an output power stage. The input voltage is taken from the main power supply (nominally 38 volts). The output voltage is sampled by the divider network of 2.0 kilohms, a 5.0 kilohm pot, and an 1.8 kilohm resistor. The sample is fed back to one input of the comparator stage and compared to the internal reference (about 7 volts). The 5.0 kilohm pot allows adjustment of the output voltage. The 1.6 kilohm resistor and 680-pF capacitor are for compensation, and the 8-ohm resistor is for overload current-limiting. The modulating input (MOD INPUT) allows the output to be one of the following:

- Square-wave modulated (28 V p-p, 400 Hz) in the AUTO mode (for automatic noise figure measurements)
- 28 V dc in the MAN ON mode
- Approximately 0 volts in the MAN OFF and CAL modes.

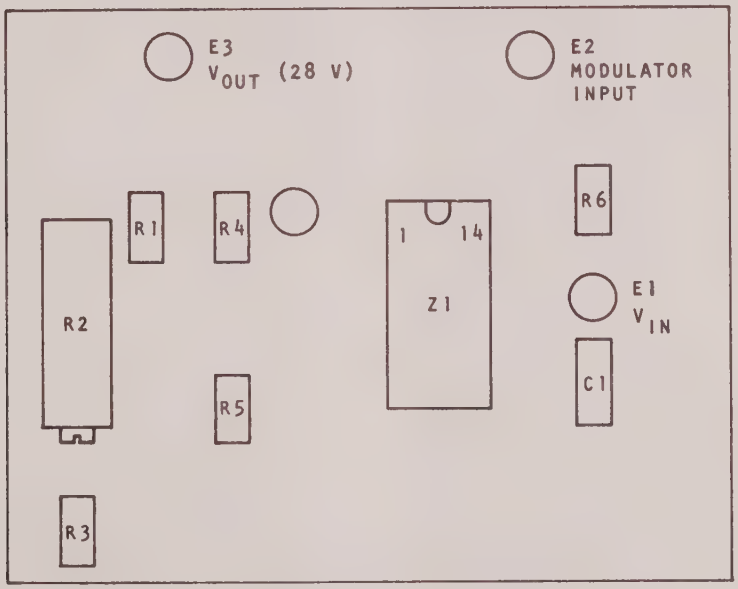
The modulating circuit consists of:

- 2.5 kilohm resistor on the 28 V dc supply PC board
- Q806
- 11 kilohm resistor (R817)
- A 5-volt logic input located on the Noise Generator Control Board (P/N 300401). C804 (0.022 μF) and R818 (2.4 kilohms) are removed entirely from the noise generator control board.

The 28-volt output is available from a BNC jack on the rear panel of the PANFI when the GAS/DIODE switch on rear panel is in the DIODE position. The 28-volt modulator PC board is located on the right side-wall of the PANFI chassis just behind the front panel.



A. SCHEMATIC



B. COMPONENT LAYOUT

FIGURE 6-18. TYPE 76 MODULATOR

6.4.10 07530 TUNABLE CONVERTER (OPTIONAL)

The frequency converter is designed to be installed into the PANFI so that the instrument can accept input frequencies in the range of 40 to 150 MHz.

The input section consists of a double-balanced mixer and a local oscillator. The local oscillator is tunable by means of a shaft extending through the front panel of the Type 75. The local oscillator operates from 70 to 120 MHz. (Refer to schematic Figure 6-19 and component layout Figure 6-20.)

The output of the mixer is internally connected to the second section. This section is made up of a filter and a 30-MHz amplifier. The filter is a five-section bandpass filter centered at 30 MHz and is designed to provide a minimum of 50-dB rejection at 70 MHz. The gain of the amplifier is adjusted so that the overall gain of the filter-amplifier and converter assembly is unity. (Refer to schematic Figure 6-21 and component layout Figure 6-22.)

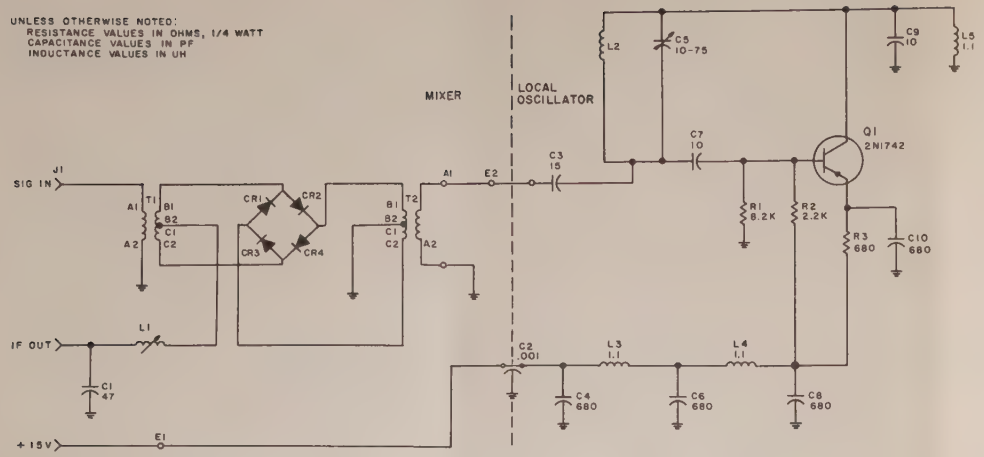


FIGURE 6-19. SCHEMATIC DIAGRAM OF FREQUENCY CONVERTER

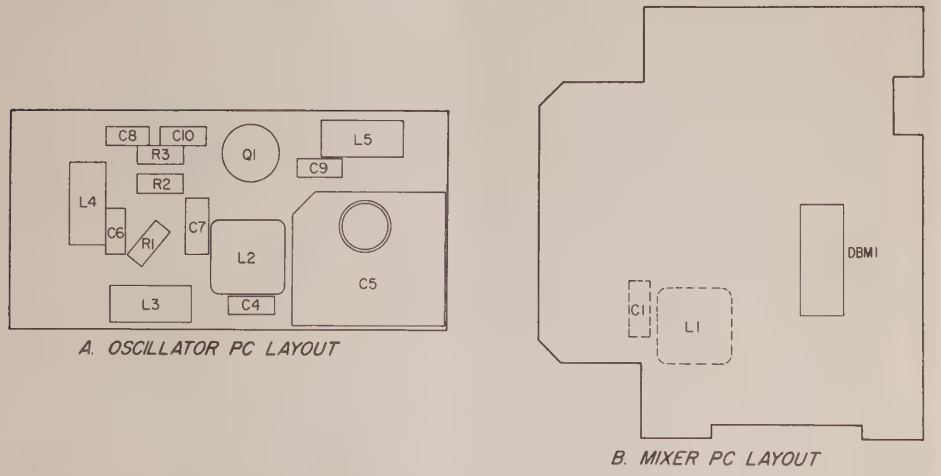


FIGURE 6-20. COMPONENT LAYOUT OF FREQUENCY CONVERTER

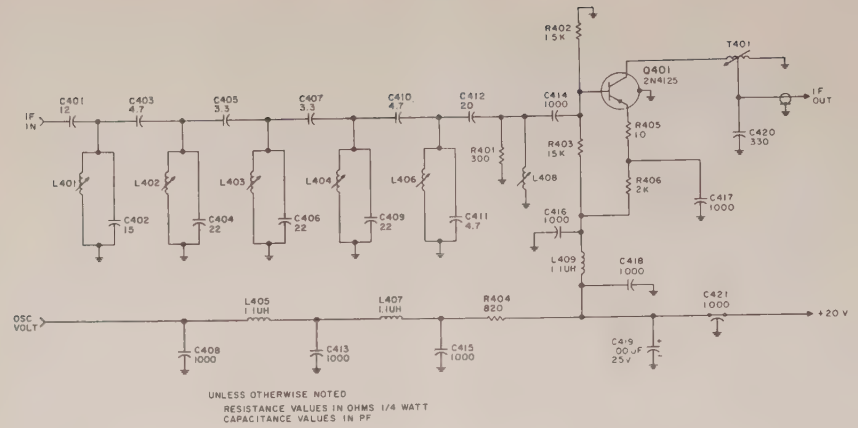


FIGURE 6-21. SCHEMATIC DIAGRAM OF FILTER-AMPLIFIER

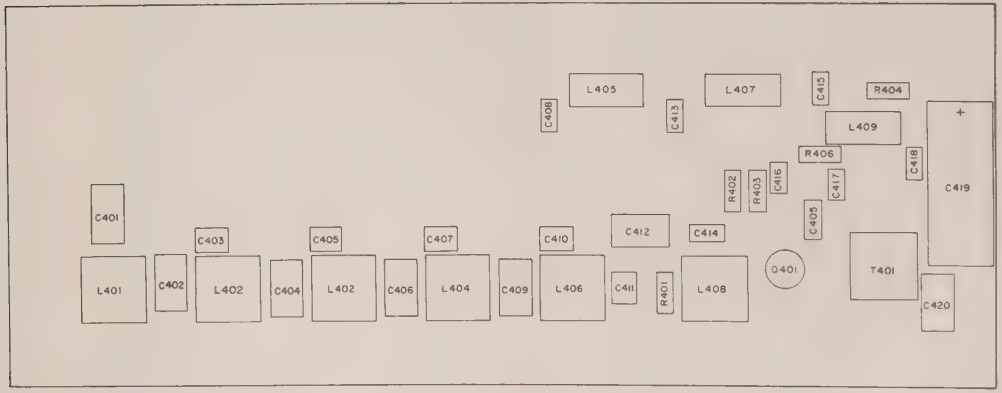


FIGURE 6-22. COMPONENT LAYOUT OF FILTER-AMPLIFIER

6.4.11 BROADBAND CONVERTER (OPTIONAL)

The Broadband Converter enables the Type 75 PANFI to accept signals from 10 to 1000 MHz. It requires an external local oscillator.

The basic Type 75 PANFI is modified by the addition of the Broadband Converter in front of its 30-MHz postamplifier. A block diagram of the converter is shown in Figure 6-23.

The 30-MHz input allows bypassing the converter (no LO needed) for signals around 30 MHz.

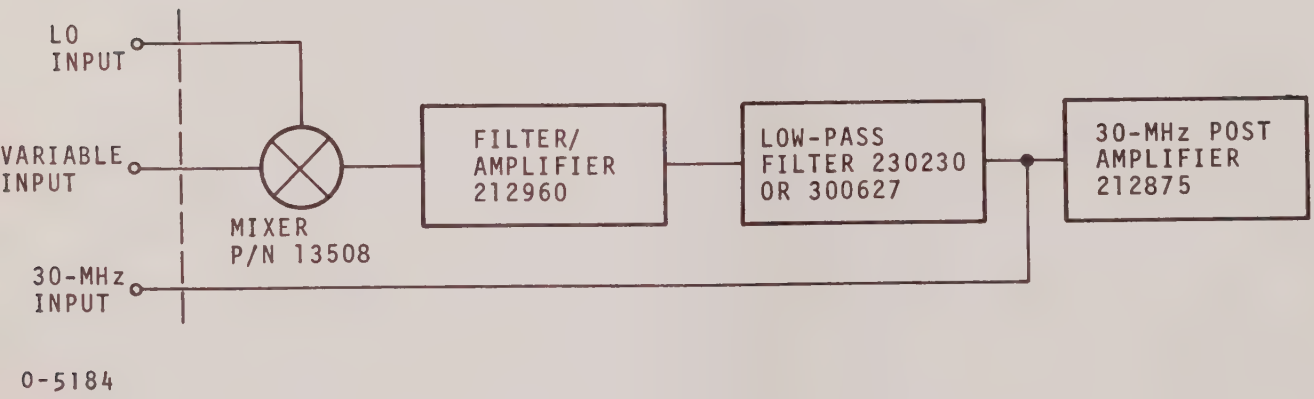


FIGURE 6-23. BLOCK DIAGRAM OF BROADBAND CONVERTER IN TYPE 75 PANFI

The broadband converter assembly is located on the upper left side of the PANFI. It consists of:

1. Coaxial Mixer - AIL P/N 13508
2. Filter Amplifier - AIL P/N 212960 (modified)
3. Low-Pass Filter - AIL P/N 230230

The coaxial mixer is a broadband, double-balanced device which operates from 10 to 1000 MHz when properly driven by a local oscillator. The mixer requires 5 milliwatts (+7 dBm) of LO power.

The filter amplifier is a bandpass filter centered around 30 MHz. This unit provides rejection of all frequencies outside of the nominal bandpass of the 30-MHz postamplifier in the PANFI. It includes an amplifier stage with gain approximately equal to the conversion loss of the mixer. The filter amplifier is the same as used in the tunable converter (07530) paragraph 6.4.10, except that it is modified for more gain and 50-ohm output impedance. R405 is 18 ohms, C420 is 68 pF, and there is a 51-ohm, 1/4-watt, 5-percent resistor (R407) in parallel with C420. The schematic is Figure 6-21 and the component layout is Figure 6-22.

The low-pass filter provides additional rejection of local oscillator output between 40 and 70 MHz. It is necessary because of the broad bandwidth of the 30-MHz postamplifier. This additional filtering permits accurate conversion of signals in the range of 10 to 40 MHz.

6.4.12 TV-75, 45.5 MHz IF (OPTIONAL)

The TV-75 PANFI has its IF amplifiers tuned to 45.5 MHz. A coaxial low-pass filter with passband cutoff frequency at 50 MHz and greater than 50 dB rejection at 100 MHz is ahead of the 45.5 MHz postamplifier. The filter is located on the underside of the chassis mounted against the AGC-IF module. A block diagram of the input stages of the TV-75 PANFI is shown in Figure 6-24.

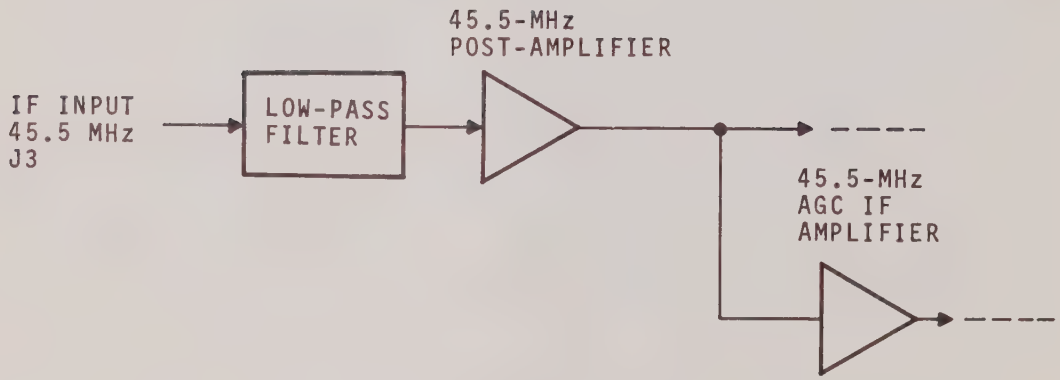


FIGURE 6-24. BLOCK DIAGRAM OF TV-75

SECTION VII

REPLACEABLE PARTS LIST

Item	Name	Manufacturer	Part No.
	MAIN CHASSIS		
C901	Capacitor, electrolytic, 100 μF, 450 V	Sprague	TVL1750
C902	Capacitor, electrolytic, 50 μF, 12 V	Sprague	TE1133
C903	Capacitor, electrolytic, 6.8 μF, 35 V	-	CS13BFG685K
C904, C905	Capacitor, electrolytic, 100 μF, 25 V	Sprague	TE1211
C906, C907, C908	Capacitor, Ceramic, 1000 pF	-	CK60AW102M
DS901	Lamp, 18 V	Chicago Miniature	CM370
DS902	Lamp, 6 V	Chicago Miniature	CM381
F901,902	Fuse, Slo Blo, 115V/1.5A Fuse, Slo Blo, 230V/0.75A	Littlefuse Littlefuse	313000/3AG1.5A 313000/3AG0.75A
J3	Jack, bulkhead, BNC	-	UG909B/U
J4	Receptacle jack, BNC	-	UG625B/U
L901, L902	Inductor, molded, 3 μH	Jeffers	10100-2
M901	Meter	AIL	212827
P1	Plug, cable, BNC	-	UG88E/U
P901	Cable and plug assembly	AIL	990050
PS901	Power supply	AIL	212967
R901	Potentiometer, 500 ohms, 3 W, 10 turn	Spectrol	532-93

Item	Name	Manufacturer	Part No.
R902	Potentiometer, 1 kΩ, 50 W	Ohmite	0326
R904	Resistor, fixed, 500 ohms, 50 W	Ward Leonard	50F500
R905	Potentiometer, 10 kΩ, 3 W, 10 turn	Spectrol	532-92
R906	Resistor, fixed, 657 ohms, ±0.5%	Mepco	FE12C1
R907	Resistor, fixed, 328 ohms, ±0.5%	Mepco	FE12C1
R908	Resistor, fixed, 249 ohms, ±0.5%	Mepco	FE12C1
R909	Resistor, fixed, 24 kΩ, 1/4 W	-	RC07GF243J
R910	Resistor, fixed, 27.4 ohms, ±1%	-	RN60D27R4
R911	Resistor, fixed, 12 kΩ, 1/4 W	-	RC07GF123J
R912	Resistor, fixed, 24.9 ohms, ±1%	-	RN60D24R9
R913	Resistor, fixed, 18.4 ohms, ±0.5%	Mepco	FE12C1
R914	Resistor, fixed, 10 ohms, ±1%	-	RN20X10R0F
R915	Resistor, fixed, 1.1 kΩ, ±1%	-	RN60C1101F
R916	Potentiometer, 200 ohms	Allen-Bradley	JA1L0405201UC
R917, 919	Resistor, fixed, 2 kΩ, 1/4 W	-	RC07GF202J
R918	Resistor, fixed, 510 ohms, 1/4 W	-	RC07GF511J

Item	Name	Manufacturer	Part No.
R924	Resistor, fixed, 10 kΩ, 1/4 W	-	RC07GF103J
S901	Switch, pushbutton	AIL	213294
S902	Switch, rotary	AIL	213349
S903	Switch, toggle	Cutler-Hammer	CH8282K14
S904	Switch, pushbutton	AIL	211824
S905	Switch, slide	Stackpole	SS-33
T901	Transformer	AIL	212243
BP901, BP902	Bind posts	Superior	DF30BC

POST-AMPLIFIER (P/N 212875)

C101-C108, C110-C117, C119-C121, C123-C128, C131-C134, C136, C142-C144	Capacitor, fixed, 1000 pF	-	CK60AW102M
C109	Capacitor, fixed, 15 pF	-	CK05CW150K
C118	Capacitor, fixed, 120 pF	Centralab	DD121
C122	Capacitor, fixed, 0.22 μF, 50 V	TRW	601 PE
C129, C135	Capacitor, electrolytic, 15 μF, 25 V	Sprague	TE1205
C130	Capacitor, electrolytic, 50 μF, 12 V	Sprague	TE1133
C137-C141	Capacitor, feedthru, 1000 pF	Allen-Bradley	FB2B
CR101-CR105	Diode	Hewlett-Packard	HPA3039

Item	Name	Manufacturer	Part No.
J1, J2	Connector, jack, BNC	-	UG1094/U
L101	Inductor, variable	AIL	212650-3
L102, L104, L106, L108, L112, L113	Inductor, fixed, 1.1 μH	Jeffers	10101-1
L103, L105, L107, L111	Inductor, fixed, 14 μH	Jeffers	10102-1
L109	Inductor, fixed, 0.47 μH	Jeffers	4411-4M
L110	Inductor, fixed, 3 μH	Jeffers	10100-2
Q101, Q102	Transistor	-	2N4125
Q103, Q104	Transistor	-	2N2996
Q105-Q108	Transistor	-	2N4123
R101	Resistor, fixed, 51 ohms, 1/4 W	-	RC07GF510J
R102, R108	Resistor, fixed, 820 ohms, 1/4 W	-	RC07GF821J
R103, R109	Resistor, fixed, 1.6 kΩ, 1/4 W	-	RC07GF162J
R104	Resistor, fixed, 33 ohms, 1/4 W	-	RC07GF330J
R105	Resistor, fixed, 100 ohms, 1/4 W	-	RC07GF101J
R106	Resistor, fixed, 360 ohms, 1/4 W	-	RC07GF361J
R107, R113 R118	Resistor, fixed, 300 ohms, 1/4 W	-	RC07GF301J
R110	Resistor, fixed, 15 ohms, 1/4 W	-	RC07GF150J
R111, R127, R128, R132	Resistor, fixed, 300 ohms, 1/4 W	-	RC07GF201J
R112	Resistor, fixed, 430 ohms, 1/4 W	-	RC07GF431J

Item	Name	Manufacturer	Part No.
R114	Resistor, fixed, 6.2 kΩ, 1/4 W	-	RC07GF622J
R115, R134	Resistor, fixed, 3.9 kΩ, 1/4 W	-	RC07GF392J
R116	Resistor, fixed, 20 ohms, 1/4 W	-	RC07GF200J
R117	Resistor, fixed, 680 ohms, 1/4 W	-	RC07GF681J
R119	Resistor, fixed, 390 ohms, 1/4 W	-	RC07GF391J
R120	Resistor, fixed, 3 kΩ, 1/4 W	-	RC07GF302J
R121	Resistor, fixed, 2 kΩ, 1/4 W	-	RC07GF202J
R122	Resistor, fixed, 620 ohms, 1/4 W	-	RC07GF621J
R123	Resistor, fixed, 120 ohms, 2 W	-	RC42GF121J
R124	Resistor, fixed, 47 ohms, 1/4 W	-	RC07GF470J
R125, R129	Resistor, fixed, 2.2 kΩ, 1/4 W	-	RC07GF222J
R126	Resistor, fixed, 75 ohms, 1/4 W	-	RC07GF750J
R130	Resistor, fixed, 2.4 kΩ, 1/4 W	-	RC07GF242J
R131, R133	Resistor, fixed, 330 ohms, 1/4 W	-	RC07GF331J
R135	Resistor, fixed, 1.3 kΩ, 1/4 W	-	RC07GF132J
R136	Resistor, fixed, 22.1 kΩ, 1/4 W, 1 %	-	RN65C2212F

Item	Name	Manufacturer	Part No.
R137	Resistor, fixed, 5.1 kΩ, 1/4 W	-	RC07GF512J
R138	Resistor, fixed, 1.5 kΩ, 1/4 W	-	RC07GF152J
T101-T103	Transformer	AIL	212567-2
T104	Transformer	AIL	212567-1

AGC IF AMPLIFIER (P/N 212881)

C202, C203, C205, C206, C207	Capacitor, fixed, .01 μF	TRW	601PE
C204	Capacitor, fixed, 39 pF	Centralab	DD-390
C208	Capacitor, fixed, 0.22 μF	TRW	601PE
C209-C216, C218-C221, C223, C224	Capacitor, fixed, 1000 pF	-	CK60AW102M
C217	Capacitor, electrolytic, 50 μF, 12 V	Sprague	TE1133
C222	Capacitor, electrolytic, 15 μF, 25 V	Sprague	TE1205
C225-C228	Capacitor, feedthru, 1000 pF	Allen-Bradley	FB2B
CR201, CR202	Diode	Hewlett-Packard	HPA3039
L201	Inductor, fixed, 3 μH	Jeffers	10100-2
L202, L204-L206,	Inductor, fixed, 1.1 μH	Jeffers	10101-1
L203	Inductor, fixed, 14 μH	Jeffers	10102-1
P2	Plug, BNC	-	UG88E/U
R201	Resistor, fixed, 51 ohms, 1/4 W	-	RC07GF510J

Item	Name	Manufacturer	Part No.
R202	Resistor, fixed, 4.7 kΩ, 1/4 W	-	RC07GF472J
R203	Resistor, fixed, 6.8 kΩ, 1/4 W	-	RC07GF682J
R204, R218, R220	Resistor, fixed, 330 ohms, 1/4 W	-	RC07GF331J
R205	Resistor, fixed, 1 kΩ, 1/4 W	-	RC07GF102J
R206	Resistor, fixed, 100 ohms, 1/4 W	-	RC07GF101J
R207	Resistor, fixed, 100 ohms, 1/8 W	-	RN60C1000F
R208	Resistor, fixed, 1.8 kΩ, 1/4 W	-	RC07GF182J
R210	Resistor, fixed, 909 ohms, 1/4 W	-	RN65C9090F
R211	Resistor, fixed, 2 kΩ, 1/4 W	-	RC07GF202J
R212	Resistor, fixed, 43 ohms, 1/4 W	-	RC07GF430J
R213	Resistor, fixed, 82 ohms, 1/4 W	-	RC07GF820J
R214, R216, R221	Resistor, fixed, 200 ohms, 1/4 W	-	RC07GF201J
R215	Resistor, fixed, 2.2 kΩ, 1/4 W	-	RC07GF222J
R217	Resistor, fixed, 2.4 kΩ, 1/4 W	-	RC07GF242J
R219	Resistor, fixed, 3.9 kΩ, 1/4 W	-	RC07GF392J
R222	Resistor, fixed, 22.1 kΩ, 1/4 W	-	RN65C2212F

Item	Name	Manufacturer	Part No.
R223	Resistor, fixed, 5.1 kΩ, 1/4 W	-	RC07GF512J
R224	Resistor, fixed, 1.5 kΩ, 1/4 W	-	RC07GF152J
	AGC AMPLIFIER (P/N 212935)		
C501, C503, C507, C510	Capacitor, fixed, 1000 pF	-	CK60AW102M
C502, C505, C508, C509	Capacitor, fixed, 1000 μF, 25 V	Sprague	TE1211
C506	Capacitor, electrolytic, 2.2 μF, 6 V	-	CS13BE225
C511	Capacitor, fixed, 270 pF	Elmenco	DM10F-271J
CR501, CR502, CR504, CR505, CR506	Diode	-	1N2071
CR503	Diode	-	1N936
L501	Inductor, fixed, 1.1 μH	Jeffers	10101-1
Q501, Q504	Transistor	-	2N4125
Q502, Q503, Q505, Q509	Transistor	-	2N4123
Q506, Q507	Transistor	-	2N4124
Q508	Transistor	Siliconix Inc.	U149
R501	Resistor, fixed, 75 ohms, 1 W	-	RC32GF750J
R502	Resistor, fixed, 270 kΩ, 1/4 W	-	RC07GF274J

Item	Name	Manufacturer	Part No.
R503, R505	Resistor, fixed, 5.6 kΩ, 1/4 W	-	RC07GF562J
R504	Resistor, fixed, 6.8 kΩ, 1/4 W	-	RC07GF682J
R506	Resistor, fixed, 3.9 kΩ, 1/4 W	-	RC07GF392J
R507	Resistor, fixed, 22 kΩ, 1/4 W	-	RC07GF223J
R508	Resistor, fixed, 82 kΩ, 1/4 W	-	RC07GF823J
R509	Resistor, fixed, 1.2 kΩ, 1 W	Dale	RS-1A
R510	Resistor, fixed, 39 kΩ, 1/4 W	-	RC07GF393J
R511	Resistor, fixed, 8.2 kΩ, 1 W	Dale	RS-1A
R512	Resistor, fixed, 1.8 kΩ, 1/4 W	-	RC07GF182J
R513	Resistor, fixed, 100 ohms, 3W	Sprague	242E1015
R514	Resistor, fixed, 1 kΩ, 1/4 W	-	RC07GF102J
R515, R516	Resistor, fixed, 47 kΩ, 1/4 W	-	RC07GF473J
R517	Resistor, fixed, 56 kΩ, 1/4 W	-	RC07GF563J
R518	Resistor, fixed, 1.3 kΩ, 1/4 W	-	RC07GF132J
R519	Resistor, fixed, 8.2 kΩ, 1/4 W	-	RC07GF822J
R520	Resistor, fixed, 5.1 kΩ, 1/4 W	-	RC07GF512J

Item	Name	Manu-facturer	Part No.
R521	Resistor, fixed, 2.2 MΩ, 1/4 W	-	RC07GF225J
R522	Resistor, fixed, 2.2 kΩ, 1/2 W	-	RC20GF222J
	VIDEO AMPLIFIER-SYNCHRONOUS DETECTOR (P/N 212920)		
C303	Capacitor, fixed, 0.047 μF	TRW	601 PE
C305	Capacitor, fixed, 0.005 μF	Erie	811-005
C306	Capacitor, fixed, 0.01 μF	TRW	601 PE
C307	Capacitor, fixed, 2200 pF	-	CK06BX222K
C309, C310 C312	Capacitor, electrolytic, 100 μF, 25 V	Sprague	TE1211
C311	Capacitor, electrolytic, 1 μF, 50 V	Hopkins	1PP5D
CR301 CR304	Diode	-	1N625
CR305	Diode	-	1N4740
CR306	Diode	-	1N2071
Q301, Q304, Q306	Transistor	-	2N4123
Q302	Transistor	-	2N929
Q303, Q305, Q307	Transistor	-	2N4125
R302	Resistor, fixed, 100 kΩ, 1/4 W	-	RC07GF104J
R303	Resistor, fixed, 820 kΩ, 1/4 W	-	RC07GF824J

Item	Name	Manu-facturer	Part No.
R304	Resistor, fixed, 220 kΩ, 1/4 W	-	RC07GF224J
R305	Resistor, fixed, 24 kΩ, 1/4 W	-	RC07GF243J
R306	Resistor, fixed, 10 kΩ, 1/4 W	-	RN20X1002F
R308	Resistor, fixed, 23.7 kΩ, 1/4 W	-	RN65C2372F
R309	Resistor, fixed, 5.6 kΩ, 1/4 W	-	RC07GF562J
R311	Resistor, fixed, 4.7 kΩ, 1/4 W	-	RC07GF472J
R312, R316	Resistor, fixed, 1 kΩ, 1/4 W	-	RC07GF102J
R313	Resistor, fixed, 560 ohms, 1/4 W	-	RC07GF561J
R314	Resistor, fixed, 22 kΩ, 1/4 W	-	RC07GF223J
R315	Resistor, fixed, 200 kΩ, 1/4 W	-	RC07GF204J
R317	Resistor, fixed, 47 kΩ, 1/4 W	-	RC07GF473J
R318, R319	Resistor, fixed, 5.11 kΩ, 1/8 W	-	RN60C5111F
R320-R323	Resistor, fixed, 2.2 kΩ, 1/4 W	-	RC07GF222J
R324, R325	Resistor, fixed, 2 kΩ, 1/4 W	-	RC07GF202J
T301	Transformer	UTC	SS0-8P

MULTIVIBRATOR (P/N 212925)

Item	Name	Manufacturer	Part No.
C602, C607, C608	Capacitor, fixed, 0.033 μF	TRW	601 PE
C603, C609	Capacitor, fixed, 0.01 μF	TRW	601 PE
C604, C606	Capacitor, electrolytic, 100 μF, 25 V	Sprague	TE1211
C605	Capacitor, fixed, 1000 pF	-	CK06AW102M
CR601, CR602	Diode	-	1N2071
Q601, Q602	Transistor	-	2N4125
Q604-Q607	Transistor	-	2N4123
R601	Resistor, fixed, 16 kΩ, 1/4 W	-	RC07GF163J
R602, R603	Resistor, fixed, 3.9 kΩ, 1/4 W	-	RC07GF392J
R604	Resistor fixed, 910 ohms, 1/4 W	-	RC07GF911J
R605	Resistor, fixed, 3 kΩ, 1/4 W	-	RC07GF302J
R606	Resistor, fixed, 3.3 kΩ, 1/4 W	-	RC07GF332J
R607	Resistor, fixed, 27 kΩ, 1/4 W	-	RC07GF273J
R608, R610	Resistor, fixed, 180 ohms, 1 W	-	RC32GF181J
R609, R621	Resistor, fixed, 12 kΩ, 1/4 W	-	RC07GF123J
R611, R620	Resistor, fixed, 390 ohms, 1 W	-	RC32GF391J
R612, R615 R616, R618	Resistor, fixed, 4.7 kΩ, 1/4 W	-	RC07GF472J

Item	Name	Manufacturer	Part No.
R613, R619	Resistor, fixed, 5.6 kΩ, 1/4 W	-	RC07GF562J
R614, R617	Resistor, fixed, 56 kΩ, 1/4 W	-	RC07GF563J

GAS-DISCHARGE NOISE GENERATOR CONTROL (P/N 300401)

C801	Capacitor, electrolytic, 15 μF, 25 V	Sprague	TE1205
C802, C804	Capacitor, fixed, 0.022 μF, 50 V	Kemet	K05SK223K
C803	Capacitor, electrolytic, 100 μF, 25 V	Sprague	TE1211
CR801 thru CR805	Diode	Kemet	1N2071
Q801, Q804 Q806, Q807	Transistor	-	2N4123
Q802, Q803	Transistor	Delco	DTS401
Q805	Transistor	-	2N2646
R801	Resistor, fixed, 47 kΩ, 4 W	Mallory	4MOL
R802	Resistor, fixed, 510 ohms, 2 W	-	RC426F511J
R803	Resistor, fixed, 3.9 kΩ, 1/4 W	-	RC07GF392J
R804, R805	Resistor, fixed, 51 ohms, 1/4 W	-	RC07GF510J
R806	Resistor, fixed, 10.5 kΩ, 1/4 W	-	RN65C1052F
R807	Resistor, fixed, 4 ohms, 1 W	Dale	RS-1A
R808, R810	Resistor, fixed, 20 ohms, 1/2 W	-	RC20GF200J

Item	Name	Manufacturer	Part No.
R809, R812	Resistor, fixed, 2.2 kΩ, 1/4 W	-	RC07GF222J
R811, R817	Resistor, fixed, 11 kΩ, 1/4 W	-	RC07GF113J
R814	Resistor, fixed, 100 ohms, 1/4 W	-	RC07GF101J
R815, R816	Resistor, fixed, 20 ohms, 1/4 W	-	RC07GF200J
R818	Resistor, fixed, 2.4 kΩ, 1 W	Dale	RS-1A
	IGNITION MODULE (P/N 300397)		
C701	Capacitor, fixed, 0.1 μF, 400 V	Sprague	4TMP10
C702	Capacitor, fixed, 0.047 μF, 400 V	Cornell-Dubilier	DPMS
CR701	Diode	EDI	8523
CR702	Diode	EDI	BCD-12
CR704	Diode	-	1N2071
P701	Connector	Bendix	FB3106A-18-8P
R701	Resistor, fixed, 5 kΩ, 25 W	Ward Leonard	25F
R702	Resistor, fixed, 1.2 kΩ, 1/4 W	-	RC07GF122J
SCR703	Diode	-	2N4172
T701	Transformer	UTC	PF3
J5	Anode connector assembly	AIL	212524
J6	Cathode connector assembly	AIL	111920

Item	Name	Manufacturer	Part No.
	TYPE 76 MODULATOR (P/N301331)		
C1	Capacitor, fixed, 680 pF	-	CK61BX681K
R6	Resistor, fixed 2.4 kΩ, 1/4 W	-	RC07GF242J
R1	Resistor, fixed 2.0 k, 1/4 W	-	RC07GF202J
R4	Resistor, fixed 8.2 ohm, 1/4 W	-	RC07GF8R2J
R5	Resistor, fixed 1.6 k, 1/4 W	-	RC07GF162J
R3	Resistor, fixed 1.8 k, 1/4 W	-	RC07GF182J
R2	Potentiometer, 5 kΩ	Bourns	3009P-1-502-5K
Z1	Integrated Circuit	Fairchild	U6E7723393

FILTER AMPLIFIER - CONVERTER (P/N 07530)

Item	Name	Manufacturer	Part No.
	(CONVERTER)		
C1	Capacitor, fixed, 47 pF	Corning	TY06-470J
C2	Capacitor, feedthru, 1000 pF	Allen-Bradley	FB2B
C3	Capacitor, fixed, 15 pF ±5%	Corning	TY06-150J
C4, 6, 8, 10	Capacitor, fixed, 680 pF	-	CK60AW681M
C5	Capacitor, variable	Hammarlund	MAPC-75
C7	Capacitor, fixed, 10 pF	Corning	TY06-100J

Item	Name	Manufacturer	Part No.
C9	Capacitor, fixed, 10 pF ±5%	Erie	831-000-P3K-100J
DBM 1	Double balanced mixer	Minicircuits Lab	ROK-2
J1	Connector, type BNC	Amphenol	31-2221
L1	Inductor, variable	AIL	118244-1
L2	Inductor, variable	AIL	210869
L3, 4, 5	Inductor, molded 1.1 μH	Speer Carbon	10101-1
Q1	Transistor	-	2N1742
R1	Resistor, fixed, 8.2 kΩ, 1/4 W	-	RC07GF822J
R2	Resistor, fixed, 2.2 kΩ, 1/4 W	-	RC07GF222J
R3	Resistor, fixed, 680 ohms, 1/4 W	-	RC07GF681J
	(FILTER AMPLIFIER)		
C401	Capacitor, fixed, 12 pF	Elmenco	DM10F-120J
C402	Capacitor, fixed, 15 pF	Elmenco	DM10F-150J
C403, 410, 411	Capacitor, fixed, 4.7 pF	Stackpole	GA
C404, 406, 409	Capacitor, fixed, 22 pF	Elmenco	DM10F-220J
C405, 407	Capacitor, fixed, 3.3 pF	Stackpole	GA
C412	Capacitor, fixed, 20 pF	Elmenco	DM10F-200J
C408, 413 - 418	Capacitor, fixed, 1000 pF	-	CK05CW102K

Item	Name	Manufacturer	Part No.
C419	Capacitor, fixed, 100 μF 25 V	Sprague	TE-1211
C420	Capacitor, fixed, 330 pF	-	CK05CW331K
L401 - 404, 406	Inductor, variable	AIL	212650-4
L405, 407, 409	Inductor, molded, 1.1 μH	Speer Carbon	10101-1
L408	Inductor, variable	AIL	212650-2
Q401	Transistor	-	2N4125
R401	Resistor, fixed, 300 ohms, 1/4 W	-	RC07GF301J
R402	Resistor, fixed, 1.5 Ω, 1/4 W	-	RC07GF152J
R403	Resistor, fixed, 15 Ω, 1/4 W	-	RC07GF153J
R404	Resistor, fixed, 820 ohms, 1/4 W	-	RC07GF821J
R405	Resistor, fixed, 33 ohms, 1/4 W	-	RC07GF330J
R406	Resistor, fixed, 2 kΩ, 1/4 W	-	RC07GF202J
T401	Transformer	AIL	212567-1